STUDIES ON RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF CHICKPEA

ABSTRACT

THESIS SUBMITTED FOR THE DEGREE OF

Doctor of Philosophy

IN

BOTANY

BY

SYED BAQAR IMAM ZAIDI

DEPARTMENT OF BOTANY
ALIGARH MUSLIM UNIVERSITY
ALIGARH [INDIA]

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ABSTRACT

Studies have been made on the rhizosphere and rhizoplane mycoflora of chickpea (*Cicer arietinum* L.) inoculated with wilt causing organism *Fusarium oxysporum* f.sp. *ciceri* as influenced by certain factors.

There was more fungal population in the rhizosphere of both healthy and wilt infected plants in comparison to non-rhizosphere. There was more population of fungi in the rhizosphere of infected chickpea plants with higher frequency values and R:S ratio than healthy counterparts. It is likely that the roots of infected plants have higher concentration of total free amino acids and sugars than healthy ones which might be favouring activity of fungi in infected rhizosphere. The roots of infected plants also have higher concentration of phenols and O-dihydroxy phenols.

Different cultivars of chickpea differed in the rhizosphere mycoflora both qualitatively and qunatitatively. There were some species of fungi found in the rhizosphere of certain cultivars only. Differences were also observed with respect to free amino acids, phenols, O-dihydroxy phenols and sugars in the root extracts from different cultivars. The cultivars

which harboured more fungi and have higher frequency of F. oxysporum f.sp. ciceri in the rhizosphere and rhizoplane have usually low concentration of free amino acids, phenols and O-dihydroxy phenols but higher concentration of sugars. The reverse was true with cultivars which harboured lower number of fungi together with lower frequency of F. oxysporum f.sp. ciceri. The number of amino acids have been relatively high in the cultivars susceptible to wilt causing organism i.e. JG-62 and H-208 as compared to BG-212 and JG-74 which are less damaged. Qualitatively, Asparagine and Histidine which have been detected in the roots of JG-62, H-208, BG-309 and JG-315 are known for their stimulatory effect on the growth of fungi while cysteine in the BG-212 and JG-74 might be contributing towards the resistance of plants against the disease. By and large, more fungi were detected in H-208, JG-62 and BG-309 than JG-74, BG-212 and JG-315. Moreover, the frequency of pathogenic fungi including F. oxysporum f.sp. ciceri was more in the rhizosphere and rhizoplane of JG-62 and H-208 and that of antagonistic fungi particularly T. viridae in BG-212 and JG-74. The fungus population was also high in the rhizosphere of H-208 and least in JG-74 in both inoculated and uninoculated plants.

There was an increase in population of fungi, R:S ratio and number of fungi in the rhizosphere and rhizoplane with age

of both inoculated and uninoculated plants. The highest rhizosphere activity was observed at flowering and fruiting stage followed by a decline at senescence. Different plant growth stages also influenced the species composition of rhizosphere mycoflora. However, Aspergilli and other saprophytic fungi constituted dominant flora throughout the growth period in uninoculated plants. On the other hand, F. oxysporum f.sp. ciceri and other parasitic fungi dominated in the rhizosphere of inoculated plants. The concentration of total free amino acids, phenols, O-dihydroxy phenols and sugars also increased with increase in age of plant being maximum in 75 to 90 days old plants followed by a decline at senescence.

Foliar spray with different growth promoting substances by and large resulted in an increase in the population and frequency of mycoflora however with maleic hydrazide, there has been a decrease in the majority of fungi including wilt pathogen F. oxysporum f.sp. ciceri except A. fumigatus, A. niger, Trichoderma lignorum. Foliar sprays with urea exhibited stimulatory effect on the activity of saprophytic as well as parasitic fungi in the rhizosphere and rhizoplane of both inoculated and uninoculated plants but with muriate of potash most of the saprophytic fungi increased while that of parasitic fungi decreased. Sprays with different fungicides brought about an inhibition in the population of rhizosphere fungi. In addition to above, the frequency of majority

of the fungi including F. oxysporum f.sp. ciceri also decreased due to foliar sprays with fungicides but that of saprophytic fungi such as Aspergillus clavatus, A. flavus, A. fumigatus and T. viridae increased. On the other hand, spray with streptomycin generally stimulated the rhizosphere fungal flora.

Incorporation of different fertilizers in the soil resulted in an increase in the rhizosphere population of fungi in uninoculated plants. Similarly, soil amendment with oil cakes, by and large, increased the rhizosphere and rhizoplane mycoflora except mahua cake. But in inoculated ones, there was a decrease in the rhizosphere and rhizoplane mycoflora activity in all the treatments except with urea and superphosphate. Different fungicides when incorporation in soil brought about a decrease in rhizosphere population of fungi both in inoculated and uninoculated plants. The frequency of most of the saprophytic and parasitic fungi including F. oxysporum f.sp. ciceri increased. with urea and superphosphate. However, with muriate of potash and different oil cakes, the frequency of most of the saprophytic fungi increased and that of parasitic fungi including F. oxysporum f.sp. ciceri decreased. With fungicides, the frequency of majority of the fungi in the rhizosphere and rhizoplane decreased. F. oxysporum f.sp. ciceri was either not detected or its frequency was low in soil treatment with castor cake, mahua cake, neem cake, bavistin, benlate and vitavax.

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1988

Dedicated to the
Memory of
Dr. Dhirendra Prakash

S. K. Saxena
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Dated....20.6.1988.....

CERTIFICATE

This is to certify that Mr. Syed Baqar Imam Zaidi has worked in this department as a research scholar under my supervision and guidance. His work "Studies on rhizosphere and rhizoplane mycoflora of chickpea" is uptodate and original. He is allowed to submit his thesis for the award of the degree of Doctor of Philosophy in Botany.

S K Saxena

(S. K. SAXENA)

C O N T E N T S

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(Syed Baqar Imam Zaidi)

Chapter One

Introduction and Review of Literature

CHAPTER - I

INTRODUCTION AND REVIEW OF LITERATURE

1.1 Rhizosphere has been defined by Hiltner (1904) as that region of the soil which is subject to the influence of plant roots and is characterized by greater microbiological activity than the soil away from the plant roots. Later terms like "Edophosphere" for the rhizosphere of Hiltner and "Histosphere" for the root surface microflora have been coined (Perotti, 1926). Clark (1949), however, suggested "Rhizoplane" for the ecological niche or habitate provided for microorganisms by root surface. However, this field of study remained somehow neglected until Starkey (1929) exhibited a relationship between the soil micro-organisms and the green plants. Since then considerable work has been done on the rhizosphere microflora of various economically important plants such as chickpea (Sondhi and Sinha, 1963; Gujrati, 1969; Mathur and Chauhan, 1972; Khan and Prakash, 1982; Satyaprasad, 1982 and Satyaprasad and Ramarao, 1983), pigeon pea (Agnihothrudu, 1955 and 1957; Rai and Upadhyay, 1980 and 1986 and Singh and Bhargava, 1981), soyabean(Rouatt et al;1963; Mohamed, 1985; and Dutta and Deb, 1986), pea (Timonin, 1940; Stenton, 1958; Luke and Devi, 1975 and Son et al., 1985), bean (Ito and

Ui, 1975 and Devet et al., 1980), broad bean (Youssef and Mankarios,1974), cluster bean (Bahadur and Sinha, 1965), lentil (Gujrati, 1969), groundnut (Krassilnikov et al., 1933; Gangawane and Deshpande, 1975 and 1977 and Gunasekar and Rao, 1982), alfalfa (Thom and Humfeld, 1932; Timonin, 1940; Ishizawa et al., 1957; Stelfox and Williams, 1980 and El-Hamolawi and Erwin, 1986), cowpea (Murthy and Raghu, 1976), wheat (Simmonds and Ledingham, 1937; Timonin, 1940; Warcup, 1957; Herr, 1957; Peterson, 1958; Moskovets, 1957; Neal et al., 1970; Chrzanowski, 1976; Hornby and Brown, 1977; Smiley, 1978; Neate et al., 1981; Ashraf, 1981; Mohamed, 1985 and Ermekova and Abirova, 1985), barley (Ishizawa et al., 1957; Kirilenko, 1970 and 1973; Murthy and Raghu, 1976; Loper et al., 1984; Gerhordson et al., 1985 and Ansari, 1982), maize (Moskovets and zhdanova, 1960; Kulshrestha, 1969; Kulshrestha et al., 1977 and Annapurna and Rao, 1983), pearl millet (Natrajan, 1972 and Ashraf, 1981), oat (Timonin, 1940; Warcup, 1957; Chester and Parkinson, 1959; Kirilenko, 1970 and 1973; Karimbaeva and Sizova, 1976; Gerhardson et al., 1985), rye (Thom and Humfeld, 1932), cotton (Clark and Thom, 1939; Patel and Iyer, 1961; Harrison and Beckman, 1982, and Moubasher and Abdel Hafeez, 1986), flax (Berezova, 1941 and Timonin, 1940b), strawberry (Katznelson and Richardson, 1948), potato (Atkinson and Robinson, 1955; Loper et al., 1984 and Choroszewski, 1985), timothy (Ishizawa, 1957), clover (Lime, 1984 and Wong et al.,

1986), redclover (Peterson, 1958), birch (Karimbaeva and Sizova, 1976), yellow birch (Ivarson and Katznelson 1960), lupin (Krivets, 1975), yellow lupin (Rataj-Guranowsky, 1981), onion (Parkinson and Clark, 1961; Fenwick, 1973 and Ashour et al., 1980), sesame (Monoharacharya et al., 1977) sunflower (Monoharacharya et al., 1977 and El-Hissy et al., 1980), ornamental plants (Yuen and Schroth, 1986), Medicago sp. (Bretage and Kollmorgen, 1986), cauliflower (Rao and Sharma, 1976), pine (Karimbaeva and Sizova, 1976 and Peno et al., 1977), spruce (Karimbaeva and Snova, 1976 and Stefurak, 1976), garlic (Bertoldi et al., 1978), Citrus sp. (Ali et al., 1979), pomegranate (Ali et al., 1979), grape vine (Ali et al., 1979), Dolichos biflavus (Behera and Patnaik, 1980), tomato (Dwivedi and Pathak, 1981; Chandra et al., 1982 and Loper et al., 1984), Cynodon dactylon (Wadhawani and Mehrotra, 1982), coffee (Venkatasubbaiah et al., 1984), date palm (Ali et al., 1979), Chrysanthemum (El-Hissy et al., 1980), Nigella sativa (El-Hissy et al., 1980), Dhatura inoxia (El-Hissy et al., 1980), Hyosymus muticus (El-Hissy et al., 1980), Cycas revoluta (Wadhwani and Srivastava, 1985), radish (Loper et al., 1984; Gerhardson et al., 1985), sugarbeet (Loper et al., 1984; Lee et al., 1985 and Vesely, 1985 and 1986), Doctylus glomerata (Kutrzeba, 1984), lettuce (Gerhardson et al., 1985), rape (Gerhardson et al., 1985), banana (Goos and Timonin, 1962), cucumber (Vancura and Hovadik, 1965 and Hong, 1969) sugarcane (Prakash, 1967;

Robinson, 1970, Kamal and Singh, 1974; Kishan et al., 1982 and Kao and Hsich, 1985), tobacco (Luke and Devi, 1972) and Abelmoscus esculentus (Dayal and Srivastava, 1975 and Srivastava and Dayal, 1986). These studies have indicated an interaction between soil microbes, soil borne pathogens and higher plants (Starkey, 1929; Timonin, 1940; Agnihothrudu, et al., 1955; Agnihothrudu, 1957, 1958 and 1960; Skilyagina, 1967; Mukerji, 1968; David and Baker, 1970; Linderman, 1970; Reddi and Rao, 1972; Mall, 1973; Raicu and Stan, 1975; Wnekowski, 1975; Newman, 1978; Arora and Dwivedi, 1979; Singh et al., 1979; Marois and Mitchel, 1981; Stenek, 1981; Sheata et al., 1983; Kurtzeba, 1983; Upadhyay and Bharat Rai, 1983; Gokulapalam, 1984; Bristo and Wyllie, 1984; Mohamed, 1985; Beggle-Ristaino and Papavizas, 1985; Kao and Hsich, 1985; Zozzerini and Tosi, 1985; Camporota, 1985; Gerhardson et al., 1985; Vesely, 1986; Upadhyay and Rai, 1986; Yuen and Schroth, 1986; Lockwood, 1986; Arora, 1986; Srivastava and Dayal, 1986 and Phillips, 1986). It has now been shown that rhizosphere microflora have a definite role to play in the development of root diseases (Agnihothrudu, 1959, Timonin, 1966; Srivastava, 1968; Vishwanath et al., 1969; Garrat, 1970; Voronkevich et al., 1972; Louvet, 1972; Samiilenko and Gvozdyak; 1972, Goel and Mehrotra, 1974; Berestetskii, 1974; Pieczarka and Lorbeer, 1975; Zhukovskaya, 1976; Gilligan, 1979; Patel et al., 1981; Rotaj-Guranowsky, 1981; Furuya, 1981; Kutrzeba, 1984; Lim and

Cole, 1984; Choroszewski, 1985; Bretag, 1985; Gagne et al., 1985; Mohamed, 1985; Kao and Hsich, 1985; Vesely, 1985 and 1986; Upadhyay and Rai, 1986; Wong et al., 1986; Sakthival et al., 1986; Agarwal, 1986 and Ermekova and Abirova, 1986). The literature on various aspects of rhizosphere mycoflora has been reviewed by Smith (1948), Katznelson et al. (1948), Clark (1949), Lochhead (1952), Starkey (1958), Katznelson (1961 and 1965), Rovira (1965), Parkinson (1967) and Srivastava (1973 and 1974).

The rhizosphere effect infact becomes evident right from the germination of seed and emergence of roots in the early stages of plant growth. Timonin (1940) observed the development of rhizosphere microflora within three days of seed germination, but further development depended upon the normal growth of the plant. Starkey (1931), while studying the rhizosphere microorganisms of several agriculturally important plants, observed a higher number of microorganisms in soil in the immediate vicinity of the roots than in soil away from the roots. Thom and Humfeld (1932) noticed 40-70 times more fungi in the rhizosphere of corn plants than in the non-rhizosphere . Similar observations have been made by Ishizawa et al. (1957), Reddy (1959), Maliszeska and Moreau (1959), Ivarson and Katznelson (1960), Strzekzyk (1961), Rouatt and Katznelson (1961), Zagallo and Bollen (1962), Prakash (1967), Kulsherestha

(1969), Luke and Devi (1975), Dayal and Srivastava (1975), Prakash et al. (1979), Ashraf (1981) and Ansari (1982). Higher percentage of inhibitory bacteria from rhizosphere of leguminous plants (Gagne et al., 1985) and a low population of fungi in the rhizosphere of Rauwolfia serpentina (Padma and Mukerji, 1972), Allium sativum L. (Yasmeen et al., 1982) and Leucaena leucocephala (Megharaj et al., 1987) have been attributed to toxic principle present in root exudates.

Cataska et al. (1960), Dickinson and Paugh (1965a,b), Hongyal-Balul (1983) and Singh et al. (1984) pointed out that there was a relation between the colonization of roots and seed mycoflora. On the other hand, no such relation was observed by Peterson (1959). He, however, concluded that for colonization of roots soil is the primary source of inoculum. Rhizosphere has been shown to provide stimulatory effect to certain fungi (eg. Melanospora breviostrata Moron, Aspergillus gigentius Wehmer and Odeocephalum corophilum Kobayasi (Agnihothrudu et al., 1955), Rhizopus orrhizus Fischer, R. nodosus Namya, Choanephora cucurbitarum (Berk and Ray) Thaxt and 16 ascomycetes and 50 imperfect fungi excluding Penicillia (Agnihothrudu, 1957, 1958 and 1960), on Fusarium oxysporum Schl. (Wnekowski, 1975), on F. oxysporum f. sp. vasinfectum (Steve and Curl, 1980), on saprophytic colonization of F. udum (Upadhyay and Bharat Rai, 1983). The rhizosphere

effect has, however, been found to persist even after 30 days of the harvest of crop (Majumdar and Bhide, 1970). The rhizosphere microflora ~~is~~ are influenced by several factors, such as plant growth stages (Krossilinikov, et al., 1936; Roviera, 1959; Gujrati, 1969; Dayal and Srivastava, 1975; Sudha Mall, 1977; Odunfa and Oso, 1979; Khan and Prakash, 1982; Satyaparasad 1982 and Mohamed, 1985); plant type (Tolle and Rippel-Badles, 1957; Bagyaraj and Rangaswami, 1966; Oblisami et al., 1971; Karimbaeva and Sizova, 1976; Rataj-Guranowsky, 1981; Parker, 1985 and Gangawane, 1985); root characters (Timonin and Lochhead, 1948; Sivasithampam and Paker, 1979 and Wadhwani and Srivastava, 1985); nature of root exudates (Rovira, 1962; 1965 and 1969 and Gussin and Lynch, 1983); environmental factors (i.e., type, reaction and fertility of the soil, soil profiles and organic and inorganic content of soil) (Peterson, 1958; Joshi, 1982; Vardavakis, 1986 and Dick and Ali-shatayah, 1986), percentage of moisture content (Clark, 1940; Venkatesan, 1962; Gujrati, 1968 and Bissett and Parkinson, 1979), light (Roviera, 1959; Srivastava, 1971), temperature (Rouatt et al., 1963; Namordoze, 1975 and Krikun, 1985) and seasonal variation (Katznelson, 1946; Millar and Boothroyd, 1962; Marks et al., 1975; Singh and Bhargawa, 1981 and Vardavakis, 1986), soil amendment with fertilizers, nematicides, pesticides and fungicides (Clark and Thom, 1939; Absalyamova, 1963; Mishra, 1972; Dath, 1982; Singh and Prasad, 1986 and Yarden, 1986);

foliar spray with chemicals (Rovira, 1959; Balasabramanian and Rangaswami, 1973 and 1975 and Bagyaraj and Rangaswami, 1982); and interactions involving soil microbes and soil borne plant pathogens of higher plants (Skilyagina, 1967; Wnekowski, 1975; Ellingboe, 1983 and Yuen, 1986), and it (has) been modified to have favourable effect on the crop.

1.2 FACTORS AFFECTING RHIZOSPHERE

1.2.1 Plant Growth Stages

Age of the plant profoundly influenced saprophytic and parasitic rhizosphere mycoflora qualitatively as well as quantitatively (Vesely, 1985). By and large, the rhizosphere activity increased with the increase in the age of plant, attaining highest activity at the peak of vegetative growth of the plant (Timonin, 1940; Khasanov, 1967 and Sudha Mall, 1977). Krossilnikov et al. (1936) observed a rise in the population of microorganisms during the early growth period and at the time of formation of fruit as well. Rao (1962) also found two peaks in the increase in the rhizosphere (ie. at the time of flowering and at senescence). Gujrati (1969) and Khan and Prakash (1982) reported higher rhizosphere fungal population at flowering and fruiting stages followed by a decrease, but there was again an increase at senescenece stage of lentil and gram. Luke and Devi (1975) observed an increase in rhizosphere activity for 30 days of vegetative growth and

during flowering and fruiting of pea plant. Riviera (1959) noticed that the rhizosphere activity of wheat reached a distinctive peak at the tillering stage influencing fungi more than bacteria. However, Khasanove (1967), Dayal and Srivastava (1975) and Behera and Patnaik (1981) observed that the population of fungi in the rhizosphere of different plants increased upto the flowering stage followed by a reduction as the plant attained senescence. Two peaks in the rhizosphere activity during the growth of the plant were also observed by Odunfa and Oso (1979). Rhizopus, Pythium and other phycomycetes fungi dominated at the seedling stages of growth but were succeeded by Fusarium, Curvularia, Phoma and many sterile mycelia at a later stage. Mohamed (1985) observed that the population of Streptomycetes sp. in the rhizosphere of wheat and soyabean were scare during the week of seed germination, gradually increasing to maximum at 3-4 wks and then declining. Mishra and Kamal (1972) recorded highest population of fungi at maturity in the rhizosphere in Euphorbia hirta, E. thymifolia, Phylanthus sp., P. niruri and Smilex. Satyaprasad (1982) although observed an increase in the rhizosphere effect in both resistant and susceptible chickpea varieties with increasing age but the population was greater in susceptible varieties.

1.2.2 Root Character

Dadalauri and Kotishvili (1975) concluded that the distribution of fungi depended upon the characters of root,

at a particular age, and not all the parts of the plant are identical in supporting the rhizosphere population. Timonin and Lochhead (1948) reported more rhizosphere activity in the central or crown portion of the root, which decreased with increasing distance both in horizontal and in vertical direction from the base of the stem. Both qualitative and quantitative differences in the rhizosphere population were observed at different depths of soil profile (Bagyaraj and Rangaswami, 1966; Hussey, 1977; Behera and Mukerji, 1979 and Choe et al., 1986). Sivasithampam and Paker (1979) observed higher population of bacteria, actinomycetes and fungi in the rhizosphere of seminal roots of wheat than the nodal roots. Differences in the rhizosphere activity were also observed between corolloid and normal roots of Cycas revoluta Thomb (Wadhwani and Srivastava, 1985).

1.2.3 Plant Type

Rhizosphere of different plants have selective effects on fungi. Certain fungi from the rhizosphere of wheat failed to develop in the rhizosphere of other plants (Tolle and Rippel-Badles, 1975). The rhizosphere of lucerne differed from that of cotton and that of spring wheat from winter wheat (Moskovets, 1957). Bagyaraj and Rangaswami (1966); Youssef and Mankarious (1968); Oblisami et al. (1971); Srivastava and Mishra (1971); Karimbaeva and Sizova (1976);

Rataj-Guranowsky (1981), Parker (1985) and Gangawane (1985) concluded that fungal species composition in the rhizosphere depends upon the type of the plant. Even differences in the rhizosphere microflora were observed between varieties of grapevine (Isarlishvili, 1957). Gujrati (1969) attributed the differences in the rhizosphere microflora of lentil and Cicer arietinum L. to be due to differences in the amino acid contents of root exudates of the two plants. Different rhizosphere mycoflora under different crop covers was also reported by Tandon and Tiwari (1982). Mohamed (1985) found larger number of antagonistic Streptomycetes sp. in wheat roots than in soyabeans.

1.2.4 Root Exudates

It is true that root exudates play a definite role by exuding substances from roots. The root exudates therefore, are found to differ from plant to plant and from young to old plant. There has been immense amount of literature which has been reviewed by Rovira (1962, 1965 and 1969), Scroth and Hildebrand (1964) and Wood (1960). There has been much work on the nature and magnitude of root exudates, the dimention of the rhizosphere, and the kind, sequences and extent of colonization of root surfaces by microbes (Parkinson, 1967 and Bowen, 1979). Knudson (1920) demonstrated that peas and maize plants grown under aseptic conditions in medium containing

sucrose produce considerable quantities of reducing sugars. Organic nitrogen has been shown to be exuded from roots of maize growing under sterile conditions (Lyon and Wilson, 1921). Various kinds of compounds such as vitamins (thiomine and biotin) from flax seedlings (West, 1939); glucose, flavonose and nucleotides from peas (Lundegradh and Stenlid, 1944); nucleic acids from germinating pea seeds (Fries and Forsman, 1951); amino acids and a reducing sugar similar to glucose from roots of tomato, soyabean, barley and oat (Katznelson, 1954); amino acids from pea roots (Rovira, 1956a); glucose, fructose, ribose, galactose and xylose from clover roots (Smith, 1966); lucine, methionine, glutamic acid, aspartic acid, cystine, phenylalanine, arginine (amino acids); rhamnose, arabinose, glucose, fructose, sucrose and raffinose (sugars) from roots of some leguminous crops (Roy and Dwivedi, 1967); organic acids and sugars from the root exudates of Sorghum vulgare and Brassica juncea (Bhuvaneshwari and Subba Rao, 1957); fatty acids (Palmaic, stearic and oleic acid) from bean (Papavizas and Kovacs, 1972) have been reported. Qualitative and quantitative changes in the nature of root exudates have also been found between resistant and susceptible varieties of Hibiscus esculentus (Afifi, 1976). Similar, results have been reported by Furgal-Wegrzycka (1984), Cahill et al. (1985), Mikzak et al. (1985a) and Chaudhary et al. (1986). Satyaprasad and Rama Rao (1983) found qualitatively more amino acids in

the exudates of susceptible in comparison to resistant variety of chickpea. Aspartic acid, asparagine and histidine were detected only in the exudates of the susceptible variety while cystine and galactose were consistently present in the exudates of the resistant variety. Mikzak et al. (1985b), found that aspartic acid was higher in susceptible cultivars while methionine, glycine, leucine and proline were higher in resistant cultivars of hops.

Srivastava (1973) demonstrated a direct relationship between rhizosphere microflora and amino acids in the root exudates and root extracts of Echinochloa curs-galli and Papsalum seorbiculatum. Sullia (1973), while studying the effect of root exudates and root extracts of Cassia tora and Crotolaria medica, observed that they stimulated the growth of most of fungi except Trichoderma lignorum (Tode) Harz. Buxton (1957) observed that oospores of Pythium mamillatum Merrs. failed to germinate in non-rhizosphere soil or in distilled water but germinated in the presence of growing turnip seedlings. Similarly Coley-Smith and Hickman (1957) observed that the sclerotia of Sclerotium cepivorum Berk. germinated in the presence of onion roots. Roy and Dwivedi (1967) found complete inhibition of conidial germination of Helminthosporium sativum Pammel, King and Bakke and Fusarium culmorum (Smith) Sacc. on glass slides in sterilized soil, but the majority of conidia germinated in the vicinity of wheat seedlings. Youssef

and Mankarios (1969) reported that root exudates of broad bean and cotton stimulated spore germination and growth of rhizosphere fungi. Sharma and Sinha (1974) observed stimulation in germination of fungal spores in the exudates of linseed roots. Schench and Stotzky (1975) pointed out that volatile compounds from germinating seeds of six plant spp. increased growth of several fungi and bacteria, including Erwinia carotovora (var. carotovora), Agrobacterium tumefaciens, Fusarium oxysporum f. sp. conglutinans and Trichoderma viride. Karimbaeva and Sizova (1977) observed a positive relationship of concentration of root exudates on growth of fungi. Gussin and Lynch (1983) found that Fusarium culmorum caused more inhibition of plant growth of wheat, barley and rye grass when grown on root exudates than when present as a spore suspension in sand. El-Hamalawi and Erwin (1986) found a three to four fold higher spore germination of Phytopthora megasperma f. sp. medicaginis in root extracts and root exudates of alfalfa than in water.

Tu (1972), while studying seed and root exudation in relation to Rhizoctonia damping off of various crops, concluded that the incidence of disease appeared to be mainly affected by the nature of the exudates. Afifi (1976) observed a correlation between the pathogenic potentialities of Fusarium oxysporum, F. moniliforme (Gibberella fujikuroi), F. solani and F. semitectum and volatile and gaseous exudates of germinating

seeds or roots of Hibiscus esculentus, ~~and found that~~ exudates from the susceptible cultivar stimulated conidial germination of all ~~the~~ four fungi whereas those from the resistant cultivar stimulated germination of only F. moniliforme. Satyaprasad and Rama Rao (1983) observed that root exudates from a susceptible Cicer arietinum L. cultivar stimulated mycelial growth and germination of conidia and chlamydospore of the wilt pathogen (Fusarium oxysporum f. sp. ciceri), while those from a resistant cultivar exhibited inhibition. Furgal-Wegrzycka (1984) found that mycelial growth and sporulation of Fusarium spp. and Ascochyta spp. were inhibited by extracts of resistant but not those of susceptible pea lines.

Burden et al. (1974) attributed natural resistance in pea and bean against root rot to be due to antifungal compounds secreted by roots. Similarly, Salt (1982) observed that wilt resistance in fababean was related to β-alanine content of seed, root and root exudates. Mikzak et al. (1985a) reported that contents of phenols, chlorogenic acid and monophenol/polyphenol ratio were indicators of resistance to Verticillium albo-atrum and Fusarium sambucianum (Gibberella pulicaris). The concentration being higher in resistant hops. Mikzak et al. (1985b) also found that in hop cultivars susceptible to Verticillium albo-atrum and Fusarium sambucianum (Gibberella pulicaris), the level of aspartic acid was higher ~~(but)~~ than that of glycine,

leucine, and proline in the resistant cultivars. Deacon and Mitchell (1985) attributed resistance of oat roots to Allomyces arbuscula, Aphanomyces sp., Phytopthora cinnamomi, Pythium aphanidermatum, P. arrhenomanes, P. graminicola, P. intermedium, P. ultimum var. sporangiferum and Sporolegnia litoralis to be due to saponin in the root.

1.2.5 Soil Type

Soil plays an important role for growth and metabolism of plant, thereby influencing indirectly the rhizosphere microflora (Dick and Ali-Shtaych, 1986). Peterson (1958), while comparing soil fungal flora around wheat and red clover, concluded that there was no difference in R:S ratio of plate counts of red clover in the three soils, however, for wheat R:S ratio was 34 in the acidic sandy loam and of 10 in neutral clay loam. Fusarium sp. was found on red clover on the root surface in acid soil, whereas Cylindrocarpon sp. in the acidic and neutral soils. Gliocladium sp. was not isolated from roots of plants growing in acid or alkaline soil but was present in neutral soil. With wheat grown in acid soil, Fusarium sp. again predominated, but in the alkaline soil Gliocladium sp. Rapidly sporing types such as Penicillium sp. were most numerous in both acid and neutral rhizosphere and root free soils for both plants, but not in chalky soil. This kind of preferential selection of fungi in different soil types has been observed

by Welte and Trolldenier, 1961; Zhdanova, 1963; Joffe, 1969; Downes, 1972; Zgorkiewicz and Mackiewicz, 1975; Bisset and Parkinson, 1979; Behera and Mukherji, 1979; Joshi, 1982, Vardavakis, 1986; Dick and Ali-Shtayah, 1986. However, Kamal and Singh (1969) found no significant effect of soil factor on distribution of fungal population.

1.2.6 Soil Moisture

Early studies by Clark (1940) and Timonin (1940 showed increased microbial counts in the rhizosphere of wheat and flax, respectively, as the soil moisture content decreased. Similar observations were made later by Clark (1948) with soybean. Tresner (1954) observed that the size of the soil microfloral populations was correlated with the moisture and organic matter content of the soil. Venkatesan (1962) obtained highest counts of bacteria, fungi and actinomycetes in the rhizosphere of rice in soil with 20% and 40% moisture, but the R:S ratio increased with greater moisture content until saturation, the high R:S values under submerged conditions were probably due to low soil counts. Sondhi (1964) observed a greater fungal species and higher population in the rhizosphere of Cicer arietinum at 15% moisture than at 25% or 35%. Soil analysis of Cicer arietinum and Lens culinaris by Gujrati (1968) showed that a change in the moisture content

had a pronounced effect on the fungal flora. Similar results were obtained by Bissett and Parkinson, 1979 and Manoharacharya and Bilolikar, 1979.

1.2.7 Light and Temperature

Rovira (1959) studied the effect of light and temperature on root exudation. In the wheat rhizosphere, Rouatt and Katznelson (1960) observed that reduction in different bacteria coincided with the reduction of light from 1,000-300 ft.c. However, Peterson (1961) stated that shading of plants had no appreciable effect on vegetatively active fungi colonizing the primary root of wheat and soybean seedlings. Srivastava (1971) studied the effect of continuous light and continuous dark on the rhizosphere and rhizoplane microflora of wheat and barley. They concluded that amino acids in root extracts were higher in plants exposed to continuous light corresponding with higher microbial populations in the rhizospheres of these plants.

A detailed study of temperature effect has been carried out by Rauatt et al. (1963) with wheat and soybean grown at three ranges of temperature (i.e. 55-60°, 70-75° and 85-90°F). Numbers of bacteria in the rhizosphere and rhizoplane of wheat increased as the temperature decreased, whereas numbers in the root free soil and on soybean roots increased with increased temperature. Fungal isolation showed a higher incidence of

Mucor, Rhizopus, Rhizoctonia and Gliocladium spp. on soybean at high temperature whereas species of Fusarium and Cylindrocarpon were prevalent at low temperature. However, the most most striking feature was the predominance of non-sporing hyaline type at low temperature. The results suggested that temperature exerted both direct and indirect effect on the rhizosphere population. The later being more important. Namoradize (1975) tabulated effect of different temperatures on the development of Fusarium species isolated from peach roots where minimum temperature for mycelial growth of F. oxysporum and F. solani was 10°, optimum 25-30° and maximum 35°C. Sporulation was observed only at 15-30°. Spore germination occurred at 5-37° with optimum temperature of 20-30°C. It is suggested that no generalization can be made with respect to occurrence of different fungi as influenced by temperature. But large no of fungi are found at temperatures at which the growth of the plant is favoured (Marks, et al., 1975; Bissett and Parkinson, 1979, and Phillips, 1986).

1.2.8 Seasonal Variation

The primary factor responsible for rhizosphere phenomenon is plant itself. So any condition that significantly effects its morphology and physiology will be reflected in quantitative and qualitative changes in the microflora of root zone. In addition to various effects of stage of the plant

growth and kind of the plant, the percentage of moisture content, reaction and fertility of the soil, environmental factors such as light, temperature and seasonal variations, and plant treatment effect the rhizosphere population to a varying degree by influencing the plant growth. They also exert a direct though considerable less effect on micro-organism themselves. Seasonal effects as reported by various workers (Katznelson, 1946; Millar and Boothroyd, 1962) may be considered to reflect the combined influence of all these environmental conditions. Panwar et al. (1967) observed that Rhizopus, Aspergillus, Penicillium, Chaetomium, Neocosmospora, Alternaria, Helminthosporium, Curvularia and Fusarium were some of the common genera which occurred practically all the year round, while the activity of certain forms like species of Choenophora, Cunninghamella, Sordaria, Monocillium, Myrothecium, Cladosporium Cylindrocephalum, Cephalosporium, Trichothecium sporotrichum and Phoma varied with the plant and the season. Marks et al. (1975) studied quantitative variation in population levels of Phytopthora cinnamoni in Euclyptus forest soil of Eastern Victoria. There was marked seasonal variation in the Population Density Index (PDI), especially on the (high) hazard site. Minimum values occurred in winter and maximum in summer. Gangawane and Deshpande (1977) observed qualitative and quantitative differences in the rhizosphere mycoflora of groundnut in response of seasonal variations. Davet et al. (1980) studied rhizosphere

mycoflora of bean (Phaseolus vulgaris) and observed that Fusarium solani occurred throughout the year while Rhizoctonia solani was favoured by warm temperatures and Pythium aphanidermatum by the rainy season. Similar seasonal variations in the occurrence of fungi in the rhizosphere has been reported by Padma and Mukerje, 1972; Subramaniyan and Rao, 1977; Bisset and Parkinson, 1979; Manoharachary and Bilolikar, 1979; Singh and Bhargawa, 1981 and Vardavakis, 1986.

1.2.9 Soil Amendment

Organic amendment of soil has been a village practice for a long time without realising its implication in disease control. Clark and Thom (1939) reported that rhizosphere microbial population of cotton and wheat responded favourably to organic manuring. There have been other reports of increases in microbial populations due to organic amendments (Absalyamova, 1963; Bumbieris, 1969; Khanna and Singh, 1975; Ashraf, 1981 and Ansari, 1983). Venkateson (1962) pointed out that, although initially there was a decrease in rhizosphere population of bacteria and fungi in a rice field due to organic amendments, but after 45 days the R:S ratio increased. Not only organic amendment but incorporation of fertilizers also has resulted in an increase in the microbial counts (Mosolov et al., 1959; Gadzhieva, 1959; Jalaluddin, 1975 and Ansari, 1983). Samtsevich and Borisova (1961) pointed out that, although in pot experiments

soil amendment with mineral and organic fertilizers had little effect on microbial counts in uncropped soil or in wheat rhizosphere, but in field experiments there had been a significant increase in the rhizosphere population which however depended on the time of the year. Mishra (1972) recorded a stimulation in the rhizosphere mycoflora of Oryza sativa L. as a result of incorporation of superphosphate. Bagyaraj and Rangaswami (1967), on the other hand, recorded a decrease in population of fungi in the rhizosphere of Eleusina coracana Gaertin due to amendment with fertilizers. At the other extremes, Voroshilova (1956), Katznelson et al. (1959), Lochhead (1959) and Baker and Nash (1965) observed that rhizosphere population was not affected by soil amendments.

This principle of modification of rhizosphere mycoflora has been employed in controlling the disease (Davey and Papavizas, 1960 and Singh et al., 1985). Davey and Papavizas (1959 and 1960) pointed out that addition of organic materials although resulted in an increase in microbial population but suppressed the root rot of beans caused by Rhizoctonia spp. Chauhan (1963) observed a reduction in the incidence of Fusarium wilt of gram (Cicer arietinum L.) by amending the soil with groundnut, till (Sesamum indicum) or mustard oilcake. Srivastava and Sinha (1971) reported a reduction in wilt of coriander (Coriandrum sativum L.) caused by Fusarium oxysporum f.

sp. coriandri Narula and Joshi by soil amendment with oilcakes. Soil amendment with chitin, Laminarin, wheat straw and over-dried green clover has been reported to inhibit the microbial population in soil and activity of Verticillium dahliae (Jarden et al., 1972). Population of Fusarium ~~as a result of organic amendments~~ was reduced by volatile degradation products of oilseed amendments (Zakaria et al., 1980). Fungistatic effect against pathogenic fungi has been reported due to soil amendment with mesocarp, root, seed and skin extract of avocado trees (Wehner, 1982) and with N and chitin against Fusarium oxysporum f. sp. ciceri (Satyaprasad and Rao, 1982). There has been reduction in the population of sclerotia of Corticium sasakii (rice pathogen) due to amendment of soil with dhaincha (Sesbania sp.) followed by sunnhemp and mung (Dath, 1982). Similar reduction in population of soil borne pathogens have been reported by Lumsden (1983) and Sinha and Prasad (1986). ~~There have been report~~ where incidence of diseases also have been found to increase due to soil amendments. Son et al. (1985) reported that incidence of Ginseng root rot caused by Fusarium solani increased due to soil amendment with ~~amendments of~~ crushed wheat, sweet potato stalk, chinese cabbage, ginseng leaves and soybean pods, but soil amendment with garlic roots, walsh onion, cabbage leaf and stalk, green onion stalk, wheat straw and barley straw decreased the incidence. Similarly Moubasher and Abdel Hafez

(1986) pointed out that there had been stimulation of rhizosphere fungi of cotton and root pathogens (i.e. Rizoctonia solani, Fusarium oxysporum and F. moniliformae (Gibberella fujikuroi)) by dung manure, clover straw and wheat straw.

O'Rouke and Miller (1966) pointed out that soil amendment with fertilizers decreased the incidence of alfalfa root rot and recovery of Fusarium spp. from roots and rhizosphere. Reductions in the number of propagules of Fusarium oxysporum f. sp. niveum (wilt pathogen of watermelon) due to soil amendment with N fertilizers, including urea and KNO_3, and increases in population with ammonium sulphate have been reported by Huang and Sun (1982). Addition of urea in soil increased the amount of ammonia which resulted in the decrease in the population of Pythium ultimum, Thielaviopsis basicola and Macrophomina phaseolina (Lockwood, 1985). The population of Acremonium implicatum and Fusarim sacchari was recorded (reduced?) by soil amendment with inorganic substances (Narendra et al., 1985). This was attributed to be due to increases in soil populations of antagonistic and fungistatic actinomycetes, other bacteria and fungi.

Inhibition of soil microorganisms and plant pathogens due to application of pesticides, herbicides, fungicides and nematicides has also been reported (Bollen et al., 1954; Bollen, 1961; Lebed, 1964; Bazhina, 1967; Alconero and

Ragedorn, 1968; Valaskova, 1968 and 1969; Smiley et al., 1970; Agnihotri, 1971; Chawdhery et al., 1972, Tu, 1972 and 1973; Singh and Prasad, 1973; Maric et al., 1974; Midhu and Nandwana, 1974; Phipps and Stipes, 1975; Jardon, 1975; Attabhanyo and Holcomb, 1976; Bertoldi et al., 1977 and 1978; El-Khadem et al., 1977; Oku, 1979; Sinha et al., 1980; Jain and Sehgal, 1980; Bartaria et al., 1982; Reis, 1982; Bollen et al., 1983; Malajczuk et al., 1983; Doneche et al., 1983; Torststensson and Wessen, 1984; Deb and Dutta, 1984; Ingham, 1985; Thind and Jhooty, 1985; Youseff et al., 1985; Yarden, 1986). This reduction has been reported in part due to direct influence on the pathogen and also in part due to disturbance of soil microflora.

1.2.10 Foliar Spray

Besides soil amendments, foliar spray of plants with chemicals which could be pesticides or fertilizers also influence the rhizosphere microflora both qualitatively and quantitatively (Rovira, 1959, Rauatt and Katznelson, 1960; Balasubramanian and Rangaswami, 1973 and 1975). Ramachandra Reddy (1959 and 1968) observed a quantitative and qualitative change in the population of bacteria, actinomycetes and fungi in the rhizosphere of rice by spraying with urea. There ~~has been~~ was a greater influence in the number of Penicillia sp. at low

Can not use this term. Only one genus of "Penicillium" recognised. Can not have plural genera; rather use Penicillium sp. (for plural species). Conferm

concentrations of urea but at higher concentrations of urea Aspergillus spp were stimulated. Horst and Herr (1962) reported an increase in the number of actinomycetes antagonistic to Fusarium roseum f. cerealis in the rhizosphere due to sprays of plants with urea. Similar increases in bacteria and antagonistic actinomycetes due to sprays with urea have been observed by Vrany (1972). As a result of spray with urea, there has been an increase in amino acid content, particularly glutamic acid and α-amino butyric acid in the root exudates of plants (Agnihotri, 1964). Sprays of plants with ammonium sulphate increased the population of fungi and actinomycetes (Bagyaraj and Rangaswami, 1982). On the other hand, a decrease in the number of fungi in the rhizosphere of wheat and maize as a result of sprays has also been observed (Vrany, 1963 and Annapurna and Rao, 1983).

Changes in the population of microorganisms in the rhizosphere as a result of sprays with other chemicals such as antibiotics, nutrients and growth regulators have also been recorded (Venkatason, 1960, Rangaswami and Vasanthrajan, 1961; Vrany et al., 1962; Kundaswamy and Rangaswami, 1967; Sullia, 1968; Gujrati, 1969; Singh, 1970; Gupta, 1971 and Chandra et al., 1982). Dwivedi and Singh (1971) noted that sprays with gibberellic acid in low concentration (i.e. 50 ppm) increased the fungal population but sprays with higher concentrations

(100 and 200 ppm) inhibited the buildup. However, maleic hydrozide was found to be inhibitory at all the concentrations tested.

Some fungicides sprayed for controlling diseases are transported downwards into roots. Thus the root exudates are also influenced, which in turn influence the rhizosphere microflora. There was a decrease in the rhizosphere population of bacteria as a result of spray with Bordeaux mixture, malachite green and Dithane Z-78 (Halleck and Cochrane, 1950) and with other fungicides (Swaminathan and Sullia, 1969 and Wainwright and Sowden, 1977).

Balasubramanian and Rangaswami (1973) pointed out that application of Diathane Z-78 (200 ppm) adversely influenced the exudation of amino acids from the roots of Sorghum vulgare and Crotolaria juncea L., which probably caused reduction in rhizosphere population of microorganisms. Similar results were obtained by Sullia (1969), Srivastava and Mishra (1971), Ranga Rao et al. (1972), Wainwright and Sowden (1977), Srivastava and Dayal (1981) and Gunasekarand Rao (1982).

1.2.11 Pathogenesis and Resistance

The intense microbial activity in the rhizosphere has direct or indirect effect on plant pathogens and development of diseases (Skilyagina, 1967; Voronkevich et al., 1972;

Mall, 1973; Wnekowski, 1975; Kutrzeba, 1984; Gagne et al., 1985 and Sakthivel et al., 1986) and vice-versa (Parlik, 1950; Agnihothrudu, 1959; Mathur and Chauhan, 1972; Stefurak, 1976; Ellingboe, 1983 and Yuen and Schroth, 1986).

By and large, the rhizosphere microflora constitute the non-pathogenic organisms. This often leads to more destructiveness caused by of soil borne pathogens in sterile than in normal, non-sterilized soil. Even susceptibility and resistance to soil borne pathogens have been related to the activity of soil/rhizosphere microflora. Reynolds (1926) correlated the resistance of flax varieties to Fusarium lini (Bolley) to the availability of hydrocyanic acid. In the plants, a greater rhizosphere activity in the susceptible varieties has been reported in ~~many~~ crops ~~eg.~~ such as flax against Fusarium oxysporum and tobacco against Thielaviopsis basicola Zopt. (Timonin, 1940), banana (Harper, 1950), maize (Horny and Ullstrup, 1967), cotton (Avezdzhanova, 1974), wheat (Srivastava and Mishra, 1972) and cauliflower (Khan et al., 1973). Species of Alternaria, Cephalosporium, Fusarium, Helminthosporium and Verticillium were more abundant in susceptible varieties of flax as compared to resistant varieties (Timonin, 1941). Winter and Rumker (1949) concluded on the basis of detailed studies ~~concluded~~ that resistance of maize and wheat to Aschochyta pinodella Johns and Fusarium culmorum (Smith) Saccardo respectively was mostly conditioned by rhizosphere microflora.

Parlik (1950) observed that Aspergillus glaucus Link and related species predominated in the sterile soil but Fusarium lini Bolley and Penicillium spp. in the rhizosphere soil of flax seedlings infected with F. lini. There has been high rate of multiplication of species of Penicillium in the rhizosphere of infected plants, but the multiplication of saprophytic bacteria and fungi was markedly reduced. Species of Aspergillus, Phoma, Pythium, Rhizoctania were found predominating in the rhizosphere of diseased plants of Pinus while of Alternaria, Cephalosporium, Meterrhizium, Spicaria and Tilachlidium spp. in healthy plant (Timonin, 1966). Buxton (1957) reported that germination of conidia of a race of Fusarium oxysporum f. pisi Linford was poor in the extract of the rhizosphere of resistant cultivar but was stimulated in that of susceptible cultivar. This led him to conclude that rhizosphere microflora is affected by the excretions from the roots of susceptible varieties. Similar results have been obtained with varieties of Gossypium arborium race indicum lini (Sulochna, 1958).

Mukhopadhyay and Nandi (1974) reported, differences between healthy jute plants and plants infected with Macrophomina phaseoli (Maubl.). Agnihothrudu (1959), while studying the rhizosphere microflora of tea in relation to charcoal stump rot caused by Ustalina zonata (Lev) Sacc., pointed out that

there were differences in density of the fungi and bacteria in rhizosphere flora of apparently healthy and infected plants. Khare (1968) recorded that the rhizosphere of diseased strawberry plants harboured more fungal population in comparison to their healthy counterparts. Powell (1969) observed that Trichoderma sp. exhibited higher frequency in healthy plants and not in infected ones.

Vishwanath et al. (1969) pointed out that the microbial populations of soil and rhizosphere were altered both qualitatively and quantitatively around diseased coffee plants. Mathur and Chauhan (1972), while studying the rhizosphere of gram infected with Fusarium oxysporum f. sp. ciceri Natuo sato., Rhizoctonia solani Kuhn and Sclerotium rolfsii Sacc., recorded higher populations of microorganisms in the rhizosphere of diseased plants. Similar results have been obtained by Srivastava and Mishra (1972) in wheat infected with Puccinia graminis var. tritici (Pers.) Eriks and Henu: by Khan et al.(1973) in cauliflower infected with Rhizoctonia solani Kuhn and Fusarium spp.; by Babushkina (1973) in cotton infected with Verticillium dahliae Kleb; by Rai and Upadhyay (1980) in pigeonpea infected with Fusarium udum; by Ashour et al. (1980); in onion infected with (Fusarium oxysporum f. sp. cepae; by Ashraf (1981) in Triticales hexaploid and Pennisetum typhoides infected with Puccinia graminis and Sclerospora sp. respectively, and by

Wadhwani and Mehrotra (1982) in smut infected plants of Cynedon dactylon. Vesely (1985) concluded that the number of pathogenic and saprophytic fungi was more on the root surface of sugarbeet plants affected by damping-off. On the other hand, Chatopadhyay and Mukhopadhyay (1967) recorded higher rhizosphere population in healthy rice plants in comparison to their infected counterparts. Similar results were obtained by Stefurak (1976) in spruce infected with Fomitopsis annosa Karst (Heterobasidium annosum), by Kannaiyan and Prasad (1981) in rice infected with Rhizoctonia solani and by Kishan et al. (1982) in sugarcane infected with Glomerella tucumensis. In multiple pathogenic conditions, such as root knot and Fusarium wilt, there has been greater microbial activity in the rhizosphere of plants. Bergeson et al. (1970) in disease complex studies concluded that Fusarium oxysporum f. sp. lycopersici was more in the rhizosphere of tomato infected with Meloidogyne javania than in rhizosphere of non-infected plants. Hirano (1983) reported that in multiple pathogenic conditions involving root-knot nematode and Fusarium sp. in tomato there has been an increase in the population of gram bacteria but reduction in Fusarium oxysporum propagulas.

1.2.12 Interactions Between Soil Microorganisms

Different rhizosphere fungi develop some kind of relationship with each other. The most important one is the antagonistic

relationship. Waksman (1944) established the existance of mycelia in soil and hence suggested active involvement of fungi in the soil ecosystem. Soil fungi such as Chaetomium spp. had an antagonistic effect on Aspergillus, Curvularia, Fusarium and Penicillium (Mukerji, 1968). Trichoderma lignorum (T. viridae), T. koningi and Pseudomonas fluroescens, Bacterium pyocyoneum (P. aeryginosa), Bacillus subtilis, B. megoterium and B. mesenterious (Anon, 1968). Babushkina (1974) pointed out that there has been more antagonistic fungi in the rhizosphere of healthy plants than that of Verticillium-infected plants. Similar results were obtained by Mall (1973). Penicillium carpeteles, Chaetomium and Trichoderma have been found antagonistic to various pathogens such as Fusarium moniliforme (Gibberella fujikaroi) (Toledo and Cardoso, 1975) Trichoderma spp. to Phytopthora nicotiana var. parasitica, Rhizoctonia solani, Fusarium oxysporum and Verticillium dahliae (Raicu and Stan, 1975), Trichoderma harzianum to Sclerotium rolfsii (Arora and Dwivedi, 1979), Corticium rolfsii, Fusarium oxysporum f. lycopersici (Endo et al., 1976). Pineda and Diaz-Palanco (1981) observed reduction in the incidence of Sclerotium rolfsii on bean by Penicillium notatum. Dwivedi and Mishra (1982) observed that Cladosporium cladosporoides was a hyperparasite on Rhizopus oryzae. Vargas and Ramirez (1983) reported that Bacillus megaterium from the rhizosphere of cotton seedlings strongly inhibited Rhizoctonia solani,

the causal agent of damping-off. Lumsden et al. (1983) established effective biological control of Sclerotium spp., Sclerotinia spp., Rhizoctonia solani and Pythium spp. by Trichoderma spp. and Gliocladium spp.; Sclerotinia spp. and Sclerotium cepivorium by Sporidesmium sclerotivorum and Coniothyrium minitans, Pythium spp. and Rhizoctonia solani by Tisaria arvalis and Fusarium spp. and Pythium spp. by Chaetomium globosum. Gokulopalan and Nair (1984) pointed out that Aspergillus niger and Trichoderma viridae were highly antagonistic to Rhizoctonia solani. Hus and Lockwood (1984) observed that Hyphochytrium catenoides could be used for biological control of Phytopthora root rot. Aspergillus niger has also been reported to be antagonistic to the collar rot pathogen, Rhizoctonia solani (Venkatasubhaiah and Safeulla, 1984). Trichoderma spp., Cynothyrium minitans and species of Fusarium and Penicillium isolated from soil have also been shown to have antagonistic effects on Sclerotinia sclerotiorum (Zozzerini and Tosi, 1985). Acrophyalophora levis, Myrothecium roridum and Paecilomyces inflatus exhibited strong antagonisms towards B. theobromae; Aspergillus niger and Memnoniella echinata towards F. solani; and Aspergillus niveus and Mimnoniella echinata towards Macrophomina phaseolina (Agarwal, 1986). Trichoderma harzianum, Penicillium purpurogenum and P. funiculosum were found to be the most antagonistic to Drechslera sorakiniona (Cochliobolus sativus) (Ermekova and

Abirova, 1986). Thus, it is clear that there are a large number of fungi which are antagonistic to pathogenic fungi and the most important one may be species of Trichoderma.

Legumes, which are ~~being next to cereals is~~ are grown the worldover as source of proteins (Allen and Allen, 1958) and form an important constituent of vegetarian diets. Besides protein, they are also source of carbohydrate, fats, vitamins and minerals.

Chickpea (Cicer arietinum L.) is the third most important pulse crop in the world from extending latitude from 15 to 40 N of equator. In India, the area under cultivation of chickpea is 9 million hectares (Chandra, 1983) and ~~amount~~ providing 90% of the world production (Verma, 1984). The yield of the crop in India is far below the average yield of chickpea in developed countries, which is partly due to poor tillage practices and partly due to damages done by diseases and pests (Pandey, 1982; Tripathi and Sharma, 1983, Singh and Bhargawa, 1985 and Grewal et al., 1985). Among the various diseases of chickpea, wilts occupy an important position in lowering the yield of crop.

The wilt caused by Fusarium oxysporum Schlecht. emend. Snyd. and Hans. f.sp. ciceri (Padwick) Snyd. and Hans. was first described by Padwick in 1940 from India. Annual losses to crop due to the disease has been estimated to be 10 percent (Haware and Nene, 1982). The causal organism is both seed

borne and soil borne (Haware et al.; 1978; Kotasthan et al., 1979; Sharma and Gupta, 1983; and Conci et al., 1985).

Soil borne diseases have been controlled by managing the rhizosphere mycoflora favouring the antagonists of the causal organism in the soil (Winter and Rumker, 1949; Babushkina, 1974; Vorgas and Remirez, 1983 and Zozzerini and Tosi, 1985). This has been successfully attempted by comparing the rhizosphere mycoflora of infected and uninfected crop followed by management of antagonists by foliar sprays and organic amendments (Davey and Papavizas, 1960 and Horst and Herr, 1962; Vrany, 1972 and 1973; and Bagyaraj and Rangaswami, 1982 and Narendra et al., 1985).

From the forgoing review of literature it is clear that very little work has been done on the rhizosphere and rhizoplane mycoflora of gram in relation to wilt disease caused by Fusarium oxysporum f. ciceri. Moreover, little information exists as to whether or not this can be controlled by modifying the rhizosphere mycoflora. Hence in the present investigations, an attempt has been made to study the following:

1. Rhizosphere and rhizoplane mycoflora of different cultivars of chickpea inoculated with F. oxysporum f. ciceri and compared with those of uninoculated plants.
2. Rhizosphere and rhizoplane mycoflora of chickpea inoculated with F. oxysporum f. ciceri at varying ages and compared with

those of
uninoculated plants.

3. Effect of spray with indole acetic acid, indole butyric acid, thio-indole butyric acid, gibberellic acid, maleic hydrazide, urea, potash, bavistin, vitavax, brassicol, benlate, captan, wettable sulphur and streptomycine on rhizosphere and rhizoplane mycoflora of cultivar JG-62 and JG-74 inoculated with F. oxysporum f. ciceri ~~(and compared with uninoculated plants)~~.

4. Effect of soil amendments with urea, superphosphate, potash, castor cake, mustard cake, neem cake, mahua cake, bavistin, vitavex, brassicol, benlate, captan, wettable sulphur on rhizosphere and rhizoplane mycoflora of chickpea cultivars JG-62 and JG-74 inoculated with F. oxysporum f. ciceri ~~(and compared with uninoculated plants)~~.

CHAPTER - II

MATERIALS AND METHODS

2.1 PREPARATION OF FIELD

Plants were grown in beds each with an area of 10 sq. meters and were given routine agronomic practices. The beds were arranged in randomised fashion and each treatment was replicated thrice.

2.2 ISOLATION OF FUNGI FROM RHIZOSPHERE, RHIZOPLANE AND NON-RHIZOSPHERE

For isolating fungi from rhizosphere, five plants were removed carefully from the field and brought to the laboratory in sterilized containers under aseptic conditions. Blocks of soil adhering the roots were cut and crushed gently with minimum damage to the roots. The roots were shaken gently to remove the superfluous soil and were transferred into a beaker containg 100 ml of sterilized distilled water and shaken. To 10 ml of this suspension 90 ml of sterilized distilled water was added in a separate container. Further, 1 ml from this solution was transferred to in another flask containing 99 ml of sterilized distilled water. Each time the flask was shaken.

In this way a suspension of 1:10,000 was obtained. With the help of a sterilized pipette, 1 ml of the 1:10,000 dilution was placed in sterilized petridishes along with 10 ml of melted cooled peptone dextrose rose bengal agar+.

The fungi developed after one week were examined and identified. The frequency was calculated by the formula:

$$\frac{\text{Number of plates containing a particular fungus}}{\text{Total plates poured}}$$

For determining the weight of rhizosphere soil, roots were removed from the original dilution flask and washed. The washed water was collected in the original flask containing stock solution. The water was evaporated on a waterbath and the soil residue was dried to constant weight in an oven at 105°C. The flask containing dry soil was weighed and the dilution factor calculated, allowance being made for the amount of soil removed in preparing the dilutions. Plate counts were made and the number of fungi per gram of oven dry "rhizosphere soil" was calculated.

+PEPTONE DEXTROSE ROSE BENGAL AGAR MEDIUM

Agar	20.0 g
KH_2PO_4	1.0 g
Peptone	5.0 g
Dextrose	10.0 g
Distilled H_2O	1000.0 ml
Rose bengal	1:30,000
Streptomycin	30 µg/ml(Martin, 1950; Johnson, 1957)

For isolating rhizoplane mycoflora the "Serial root washing technique" of Harley and Waid (1955) was employed. Roots were washed several times in sterilized distilled water, and cut into small pieces of 3 mm length, and transferred into sterilized petriplates, with five root pieces in each petriplate containing 10 ml sterilized, melted, cooled peptone dextrose rose bengal agar medium. The fungi that developed were examined and identified. The frequency of the fungi was calculated by the method given earlier.

For studying the non-rhizosphere soil mycoflora, soil was brought from uncultivated portions of the filed in a randomised manner from a depth of 10 cm. Under aseptic conditions, the samples were mixed thoroughly in order to get a composite sample. Twenty five g of soil was taken from this composite sample and transformed in 250 ml of sterilized distilled water. Flask was shaken vigorously and the resultant suspension was used as stock solution. From this stock slution a dilution of 1:10,000 was achieved by making transfers in the manner given earlier. One ml of 1:10,000 dilution was transferred into petriplates along with 10 ml of melted cooled peptone dextrose rose bengal agar medium. Petriplates were rotated gently in order to obtain an equal distribution of solution and medium. The fungi which developed were identified and counted. The frequency of the fungi was calculated by the

method discussed earlier. Dilution factor was calculated and the number of fungi of oven dry "non-rhizosphere" soil was calculated.

Rhizosphere fungal population was compared with populations of non-rhizosphere by using a numerical value. R:S ratio was calculated on the basis of:

$$\frac{\text{Number of organisms per gram of rhizosphere soil}}{\text{Number of organisms per gram of non-rhizosphere soil}}$$

2.3 CULTURE OF FUNGI

Pure culture of Fusarium oxysporum f. sp. ciceri was maintained on potato dextrose agar medium[+] . For inoculations the fungus was grown on cornmeal sand media[++], at 28°C ± 2°C for 15 days.

2.4 INOCULATION OF PLANTS WITH WILT PATHOGEN (FUSARIUM OXYSPORUM F.SP. CICERI)

The fungus was transferred into soil at the time of sowing or at seedling stage. In the former 5-10 g of the fungus was placed in the hole containing the seed while in

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[+]POTATO DEXTROSE AGAR MEDIUM

Agar	17 g
Potato (peeled and sliced)	200 g
Dextrose	20 g
Distilled water	1000 ml

[++]CORNMEAL SAND MEDIUM

Cornmeal	1000 g
Washed white sand	1000 g
Distilled water	1500 ml

The latter, fungus was transferred into holes made around the roots of 15 day old seedlings.

2.5 BIOCHEMICAL ANALYSIS OF ROOT

2.5.1 Preparation of Root Powder

Roots of both uninoculated and inoculated plants (25 plants each) were collected from the field and were washed thoroughly in running water and then in sterilized distilled water. These roots were dried in an incubator at 60°C for 48 hours and powdered in an electric grinder. The powder was sieved through 60-mesh sieve.

2.5.2 Quantitative Estimation of Total Free Amino acids

Amino acids were estimated using the method of Moore and Stein (1954) with modified ninhydrin reagent. Ninhydrin reagent was prepared by dissolving 20 g of ninhydrin and 3 g of hidrindentine+ in 750 ml of methyl cellosolve (2-methoxy-ethanol). The mixture was gently stirred. To this 250 ml of

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+HYDRINDENTIN: 8 g of ninhydrin was dissolved in 200 ml of distilled water at 90°C. In another solution 8 g of ascorbic acid was dissolved in 40 ml of distilled water at 40°C . The two solutions were immediately mixed and later cooled under tap water. The crystals of hydrindentin thus obtained after filtration were washed and dried in a vaccum dessicator in dark and stored in dark glass bottle.

sodium acetate buffer[+] of pH 5.5 was added. The resulting reddish solution was immediately transferred to a dark glass bottle.

For the preparation of standared curve, 1 mg of leucine was dissolved in 100 ml of double distilled water. One ml of this solution was diluted to 10 ml by adding required amount of water. Different aliquotes, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 ml were taken and the final volume in each case was made to 1 ml by further addition of distilled water. To 1 ml of the above solution 1 ml of ninhydrin reagent was added and the solution was passed for 15 minutes over a water bath. The violet coloured solution was diluted to 10 ml by adding more distilled water. Optical densities were measured in Bousch and Lomb Spectronic 20-Calorimeter at 570 nm against the reagent blank. A graph between the optical densities and different concentrations was plotted, which was a straight line.

[+]SODIUM ACETATE BUFFER: The 4 N sodium acetate buffer of pH 5.5 was prepared by dissolving 272 g of sodium acetate (reagent grade) in 700 ml of distilled water over waterbath. After cooling at room temperature 50 ml of glacial acetic acid was added and then final volume was made upto 500 ml. The pH of the buffer was later checked by pH meter.

For the estimation of total free amino acids, 100 mg of dried sample of powdered material were extracted with 5 ml of 80 percent boiling ethanol and centrifuged at 3000 rpm for 15 minutes. The extract thus obtained was diluted to 10 ml by adding the required amount of 80% ethanol. To 1 ml of this solution, 1 ml ninhydrin reagent and 8 ml distilled water were added and the optical densities were determined.

2.5.3 Qualitative Estimation of Amino acids

Qualitative analysis of amino acids was done by following the method of Block (1950) using descending chromatography with Watman filter paper no.1 and n-butanol:glacial acitic acid:water (12:3:5) as solvent. Alcoholic extracts of samples along with 22 known amino acids were spotted on one end of the sheet in a line with the help of micro pipette and suspended. After 10 hours, the sheets were dried in the air and sprayed with 0.2% (v/v) of ninhydrin in water saturated nutanol. The sheets were dried in air followed by drying in oven at 100°C for 2 minutes. The R/S value of various spots developing were measured and were compared with Rf values of known amino acids.

R.f. value = a/b, where a = distance travelled by the known sample in cm and b = distance travelled by the solvent in cm.

2.5.4 Estimation of Phenols

Phenols were estimated following the method of Biehn et al. (1968) using Folin-Ciocatteau reagent (Bray and Thrope, 1954). Folin-Ciocatteau reagent was prepared by dissolving 100 g of sodium tungstate and 25 g of sodium molybdate in 700 ml of distilled water. To the above solution 50 ml of 85% phosphoric acid and 100 ml of concentrated hydrochloric acid were added. This was then reflexed for 10 hours. Later 150 ml of Lithium sulphate, 60 ml of double distilled water and few drops of liquid bromine were added. The mixture was then boiled over a free flame for about 15 minutes to remove excess bromine and was cooled at room temperature. The solution was filtered and made to 1000 ml by adding more distilled water. Its normality was adjusted to 1-N before use.

A standared curve of different concentrations of phenol was prepared by dissolving 10 mg of paracresol in 100 ml of 80% butanol. One ml of paracresol solution was diluted again by adding 10 ml of 80% ethanol. From this solution, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 ml were transferred to test tubes and the volume in each case was made upto 1 ml by adding required amount of 80% ethanol. Two drops of concentrated hydrochloric acid were added and then solution was heated over flame, avoiding overheating. Thereafter, 1 ml of 1-N Folin-Ciocatteau reagent and 20 ml of 4% of sodium carbonate were

added. After 20 minutes the optical density was measured by using a Bausch and Lomb Spectronic-20-Calorimeter at 660 nm against a reagent blank. A straight line curve, obtained by plotting different concentrations of paracresol and optical densities, served as standard curve.

For estimating total phenols in the sample, 100 mg of dried, powdered sample was heated with 5 ml of 80% ethanol for 15 minutes over a waterbath; the suspension was then centrifuged for 5 minutes at 3000 rmp. The alcoholic extract was taken out and made upto 10 ml by addition of the required amount of 80% ethanol. To 1 ml of this solution, 1 ml Folin-Ciocatteau reagent, 2 drops of concentrated hydrochloric acid and 20 ml of 4% sodium carbonate were added. Optical density was measured and the concentration of phenols was calculated by comparing with the standard curve.

2.5.5 Estimation of O-dihydroxy phenols

Estimation of O-dihydroxy phenols was made following the method of Johnson and Schal (1954) by using Arnows reagent.

The following three stock solutions were prepared:

1. 0.5-N-hydrochloric acid;
2. Nitrate molybdate reagent: 10 g of sodium molybdate was dissolved in 100 ml of distilled water. In this solution 10 g of sodium nitrate was dissolved;
3. 1-N sodium hydroxide.

For obtaining standared curve, 10 mg of catechol was dissolved in 100 ml of 80% ethanol. One ml of this solution was again diluted by adding 10 ml of 80% ethanol. Different amounts of aliquotes 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 ml were taken and the final volume in each case was made to 1 ml by adding required amount of 80% ethanol. To each of the 1 ml of the above solution, 1 ml of 0.5 N HCl and 1 ml of molybdate reagent was added. As a result of which yellow colour developed. To this yellow coloured solution 1 ml of 1N NaOH was added and the volume was made upto 5 ml by adding required amount of distilled water, which resulted in the change of colour to red. This red coloured solution was read in Bausch and Lomb Spectronic 20-Calorimeter at 530 nm against reagent blank and the optical density was noted. Standard curve was obtained with the help of catechol.

For estimation of O-dihydroxy phenols, 100 mg dried sample of powdered material was extracted with 5 ml 80% boiling ethanol and centrifuged at 3000 rpm for 15 minutes, and the filtrate was collected. The final volume of alcoholic filtrate was adjusted to 10 ml by adding required amount of 80% ethanol. One ml of each of the sample obtained above was taken to 5-ml calibrated test tubes to which a reagent (containing 1 ml of 0.5 NHCl + 1 ml molybdate nitrate reagent + 1 ml of 1N NaOH + water to the final volume 5 ml) was added and the optical density was noted. The

concentration of total O-dihydroxyphenols was calculated by comparing with standard curve.

2.5.6 Estimation of Total Carbohydrates

Total carbohydrates were extracted and estimated by the method of Yih and Clark (1965) and Dubois et al. (1956), respectively.

For making standard curve, 10 mg of glucose (analar) was dissolved in 100 ml of distilled water and 1 ml of this solution was again diluted to 10 ml by adding required amount of distilled water. Different amounts viz., 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 ml of this solution were transferred to test tubes and final volume of each was made upto 1 ml by adding required amount of distilled water. To these solutions 1 ml of 5% ethanol and 5 ml of concentrated H_2SO_4 (analar) were added. After 10 minutes, the optical density was measured in a Bousch and Lomb Spectronic 20-Calorimeter at 490 nm as against a reagent blank. A graph was plotted between optical density and different concentrations of glucose which served as standard curve.

For estimation of total carbohydrates, 100 mg dried powdered sample was boiled in 5 ml concentrated 1N H_2SO_4 for 30 minutes over a waterbath and later was centrifuged at 1000 rpm for 10 minutes. The solution was collected in flask and the

residue was washed twice with distilled water. This aqueous filtrate was added to the filtrate kept in flask and volume was made upto 100 ml by adding distilled water. To 1 ml of this solution, 1 ml of 5% ethanol and 5 ml of concentrated H_2SO_4 was added. Optical density was measured and values of total carbohydrates calculated from the standard curve.

2.6 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF DIFFERENT CULTIVARS OF CHICKPEA PLANTS UNINOCULATED AND INOCULATED WITH FUSARIUM OXYSPORUM F.SP. CICERI

Seeds of different cultivars of chickpea viz., JG-62, H-208, BG-309, JG-315, BG-212 and JG-74 were sown in soil infested with F. oxysporum f.sp. ciceri. Studies for rhizosphere and rhizoplane mycoflora were made when the plants had attained the age of 45 days. Estimation of total free amino acids, phenols, O-dihydroxyphenols and sugars and qualitative detection of amino acids were also made from the roots of inoculated plants of different cultivars. Similar studies were made from plants grown in uninoculated beds to serve as control.

2.7 EFFECT OF AGE OF PLANTS ON RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF INOCULATED CHICKPEA PLANTS WITH FUSARIUM OXYSPORUM F.SP. CICERI

The seeds of cultivar JG-62 were sown after surface sterilization with 1:1000 mercuric chloride followed by

repeated washings with sterilized distilled water. Beds were inoculated with the pathogen F. oxysporum f.sp. ciceri. Uninoculated beds served as control. Rhizosphere, rhizoplane and non-rhizosphere soil mycoflora studies were made at 15-days intervals from the emergence of seedling to sensescence. Quantitative estimation were made for total free amino acids, phenols, O-dihydroxyphenols and sugars from root extract of inoculated and uninoculated plants.

2.8 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF UNINOCULATED AND INOCULATED PLANTS (WITH FUSARIUM OXYSPORUM F.SP. CICERI) OF CHICKPEA CULTIVARS JG-62 AND JG-74 IN RELATION TO FOLIAR SPRAYS

Fifteen-day-old plants of JG-62 and JG-74 inoculated with F. oxysporum f.sp. ciceri were sprayed with 100 ppm solutions of indole acitic acid, indole butyric acid, thio-indole butyric acid, maleic hydrazide, streptomycin, urea and muriate of potash; 1500 ppm of bavistin, vitavax, brassicol, benlate, captan and wettable sulphur. Similar sprays were done on uninoculated plants. In order to be sure that sprays are done on foliage, the surface was covered with plastic sheets. Plants sprayed with distilled water served as control. Subsequent sprays were done at 15-day intervals from the date of Ist spraying. After 14 days of each spray, the rhizosphere, rhizoplane and non-rhizosphere mycoflora were studied.

2.9 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF UNINOCULATED AND INOCULATED PLANTS (WITH FUSARIUM OXYSPORUM F.SP. CICERI) OF CHICKPEA CULTIVARS JG-62 AND JG-74 IN RELATION TO SOIL AMENDMENTS

The soil was amended with urea (11 lb per acre), superphosphate (20 lb per acre), muriate of potash (70 lb per acre) neem cake, mustard cake, castor cake (100 lb per acre each); mahua cake (50 lb per acre), vitavax (30 kg per hectare), bavistin, brassicol, bentate, captan and wettable sulphure (6 kg per hectare each). After 15 days seeds of JG-26 and JG-74 were sown. Half of the beds were inoculated with F. oxysporum f.sp. ciceri and half were left uninoculated. Uncultivated beds were left for non-rhizosphere studies, Rhizosphere rhizoplane and non-rhizosphere studies were made from inoculated and uninoculated plants after 60 days.

Throughout the studies the petriplates were inoculated at 28°C unless stated otherwise. For each treatment there were 20 petriplates and each treatment was replicated thrice.

Chapter Three

Experimental Results

CHAPTER - III

EXPERIMENTAL RESULTS

3.1 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF DIFFERENT CULTIVARS OF CHICKPEA INOCULATED WITH FUSARIUM OXYSPORUM F.SP. CICERI

In all, 55 fungal species were isolated from the rhizosphere of six different cultivars of chickpea tested (Table 4). ~~It was~~ There were 28, 30, 29, 27, 28 and 27 species in the rhizosphere of JG-62, H-208, BG-309, JG-315, BG-212 and JG-74 respectively inoculated with Fusarium oxysporum f. sp. ciceri, as against 25, 26, 27, 23, 22 and 26 respectively in the uninoculated plants. Thus in all the cultivars the inoculated plants harboured more fungi. In amongst inoculated ones highest number of fungi was recorded in H-208 and lowest in JG-74 and JG-315, while in uninoculated plants highest number of fungi was in BG-309 and lowest in BG-212. Aspergillus fumigatus, A. flavus, A. niger, Curvularia lunata, Drechslera hawaiensis and Cladosporium herbarum were recorded from the rhizosphere of both inoculated and uninoculated plants of all the cultivars. However, Rhizopus oryzae, was isolated from all the cultivars except inoculated plants of JG-74. Rhizopus nodosus was recorded in the rhizosphere of H-208, BG-309, JG-315 and JG-74, Cunninghamella echinulata of JG-62, H-208, BG-309,

and BG-212; Monilia humicola of JG-62, JG-315, BG-212 and JG-74; Chaetomium flavum of H-208, BG-309, JG-315 and JG-62; Aspergillus funiculosus of H-208, BG-30 and BG-212; A. flavipes of JG-62 and H-208; A. clavatus of BG-309, BG-212 and JG-74; Botryotrichum piluliferum of BG-309, JG-315; Verticillium glaucum of JG-315 and BG-212; Memnoniella echinata of JG-309, BG-212 and JG-74; A. terreus of BG-309, JG-315 and JG-7 Curvularia geniculata of BG-212; Gliocladium roseum of JG-74; Penicillium notatum of H-208, BG-309 and JG-74; Acrophialophora fusipora of JG-62. Monosporium olivaceum, F. oxysporum f.sp. ciceri, Sclerotium rolfsii, Alternaria alternata and sterile brown mycelium were recorded from the rhizosphere of inoculated plants of all the cultivars whereas Mucor racemosus was confined to only JG-62, H-208, BG-309 and JG-315; Syncephalastrum racemosum of JG-62, H-208 and BG-212; Macrophomina phasiolina of JG-62, BG-309 and JG-315; Botrytis cinerea of JG-62, H-208 and BG-212; Nematogonium humicola of JG-315, Alternaria fasiculata to H-208, BG-309 and JG-315; Mortierilla alpina to JG-62, H-208 and JG-74; and Sepdonium chrysospermum to JG-62, H-208, BG-309, JG-315; Rhizoctonia solani to JG-62, H-208 and BG-212. On the other hand, Memnoniella echinata, Trichoderma viridae and Humicola fuscotra were recorded from the rhizosphere of uninoculated plants. However, Phoma hibernica was isolated from all the cultivars except JG-62 whereas Aspergillus luchuensis was confined to JG-62, H-208

and JG-74, A. ochracious to BG-212; A. sparsus to JG-74, H-208, and BG-309; Torulla allii to JG-62, H-208, BG-309 and JG-74; F. rosium to JG-31, BG-212; F. moniliformae to JG-62 and BG-309 and sterile black mycelium to JG-62, H-208, BG-309 and JG-74.

In amongst different fungi isolated from the rhizosphere of inoculated plants, the frequency of F. oxysporum f.sp. ciceri was highest in JG-62 followed by H-208, BG-309, BG-212, JG-315 and JG-74. A. fumigatus, A. flavus, A. niger, M. humicola, C. lunata and C. flavum in JG-315. M. racemosus, M. phaseolina A. flavipes, B. cineria, A. alternata in JG-62. S. chrysospermum C. herbarum and D. hawaiensis in H-208. M. olivaceum, C. herbaru and D. hawaiensis in BG-309. A. niger and D. hawaiensis in JG-74. The frequency was lowest for A. flavus, A. niger, C. echinulata and C. lunata in JG-62; R. oryzae, A. fumigatus and sterile brown mycelium in H-20, R. nodosus, A. fumigatus in BG-309; M. olivaceum and A. alternata in BG-212 and A. niger and T. lignorum in JG-74. On the other hand, in rhizosphere of uninoculated plants the frequency of A. funigatus was highest in JG-315 and BG-212; A. flavus, C. lunata in JG-315; T. viridae in JG-315 and JG-74; C. aspermum, A. terreus, A. luchuensis, P. notatum, M. echinata and T. allii in JG-74. The frequency of C. echinulata, A. flavus, A. terreus, A. luchuensis was lowest in JG-62; R. oryzae, A. fumigatus, H. fuscotra, M. echinata, and C. lunata in H-208; F. oxysporum,

sterile black mycelium in BG-309; C. flavum in JG-315; M. humicola and A. humicola in BG-212.

In all 35 fungi were isolated from the rhizoplane of inoculated and uninoculated plants of six different cultivars of chickpea (Table-5). Thus the number of fungi was less in rhizoplane than in the rhizosphere. The number of fungi was more in the rhizoplane of inoculated plants of all the cultivars than in uninoculated plants. Highest number of fungi was found associated with the rhizoplane of H-208 and JG-62 in inoculated and uninoculated plants and lowest of BG-212 and JG-315 in uninoculated and inoculated plants. Aspergillus fumigatus, A. flavus, A. niger, Cladosporium herbarum, Drechslera hawaiensis and Curvularia lunata were isolated from the rhizoplane of both inoculated and uninoculated plants of all the cultivars. However, Cunninghamella echinulata was reported from rhizoplane of JG-62, H-208, BG-309 and BG-212; Rhizopus nodosus of H-208, BG-309, JG-315 and JG-74; R. oryzae of JG-62, H-208, BG-309, JG-315 and BG-212; Chaetomium flavum of JG-62, H-208, BG-309 and JG-315; Monilia humicola of JG-315 and BG-212; Gliocladium roseum of JG-74; Memnoniella echinata of BG-309 and BG-212; Aspergillus clavatus of BG-212 and JG-74; A. flavipes of JG-62 and H-208 and Acrophialophora fusipora of JG-62. Monosporium olivaceum, Alternaria alternata, Fusarium oxysporum f.sp. ciceri and Sclerotium rolfsii were isolated from the rhizoplane of inoculated plants of all the different cultivars

whereas Mucor racemosus from all the cultivars except BG-212; Aspergillus candidus from H-208, BG-309 and BG-212, Mortierilla alpina from JG-62, H-208 and JG-74; Botrytis cinerea from JG-62 and H-208; Sepdonium chrysospermum from H-208, BG-309, JG-315 and JG-74; Rhizoctonia solani from JG-62 and H-208. On the other hand A. terreus and sterile black mycelium were recorded from the rhizoplane of inoculated plants of all the cultivars whereas Torulla allii to H-208 and BG-309; Humicola fuscotra to JG-62, BG-212, JG-315 and JG-74; Aspergillus luchuensis to JG-62 and H-208.

The frequency of F. oxysporum f.sp. ciceri was highest in the rhizoplane of inoculated plants of all the cultivars except JG-315, BG-212 and JG-74 where the frequency of A. flavus and A. funigatus was highest. The frequency of A. flavus was highest in all the cultivars of uninoculated plants. On the other hand, the frequency was lowest for M. olivaceum in JG-62; R. oryzae, R. nodosus, M. racemosus and S. rolfsii in H-208; M. echinata in BG-309; R. nodosus, C. flavum and S. chrysospermum in JG-315; S. chrysospermum in BG-212 and R. nodosus, M. racemosus, M. alpina, A. alternata, S. rolfsii and T. viridae in JG-74 inoculated plants. In uninoculated plants the lowest frequency was that of C. echinulata in JG-62; A. terreus and A. flavipes in H-208, C. lunata in BG-309; and JG-315, M. humicola and C. herbarum in BG-212 and D. hawaiensis and H. fuscotra in JG-74.

The population of fungi was highest in cv. H-208 both in inoculated and uninoculated plants (Table - 1). It was 185000 in inoculated as against 125000 in uninoculated plants thus indicating more population of fungi in rhizosphere of inoculated plants.

There was difference in the amino acid, phenol, O-dihydroxyphenole and sugar contents of different cultivars (Table-2). The concentration of free amino acids was highest in cv. JG-74 both in inoculated and uninoculated plants. However sugar content was highest in cv. JG-62 in both inoculated and uninoculated plants. Amongst the two, the concentration was highest in inoculated plants root exudates.

Different cultivars of chickpea also exhibited qualitative differences in the amino acids (Table-3). The number of amino acids was highest in H-208, BG-309 and lowest in JG-74 and BG-212. Alanine, Aspartic acid Glutamic acid and Glycine were detected in the root extract of all the cultivars; Asparagine, Lysine and Histidine in JG-62, H-208, JG-309 and BG-212, Serine in H-208, BG-309, JG-315, BG-212 and JG-74; Tryptophane and Valine in JG-62, H-208 and JG-309, Tyrosine in JG-315, BG-212 and JG-74 and Lucine in JG-315. Phenylalanine in JG-62, H-208, BG-309, BG-212 and JG-74 and Cyteine in BG-212 and JG-74. The susceptible cultivars has higher number of free amino acids than resistant cultivars.

FIG. 1. Population of fungi in the rhizospheres of uninoculated and inoculated (with *Fusarium oxysporum* f.sp. *ciceri*) plants of different cultivars of chickpea.

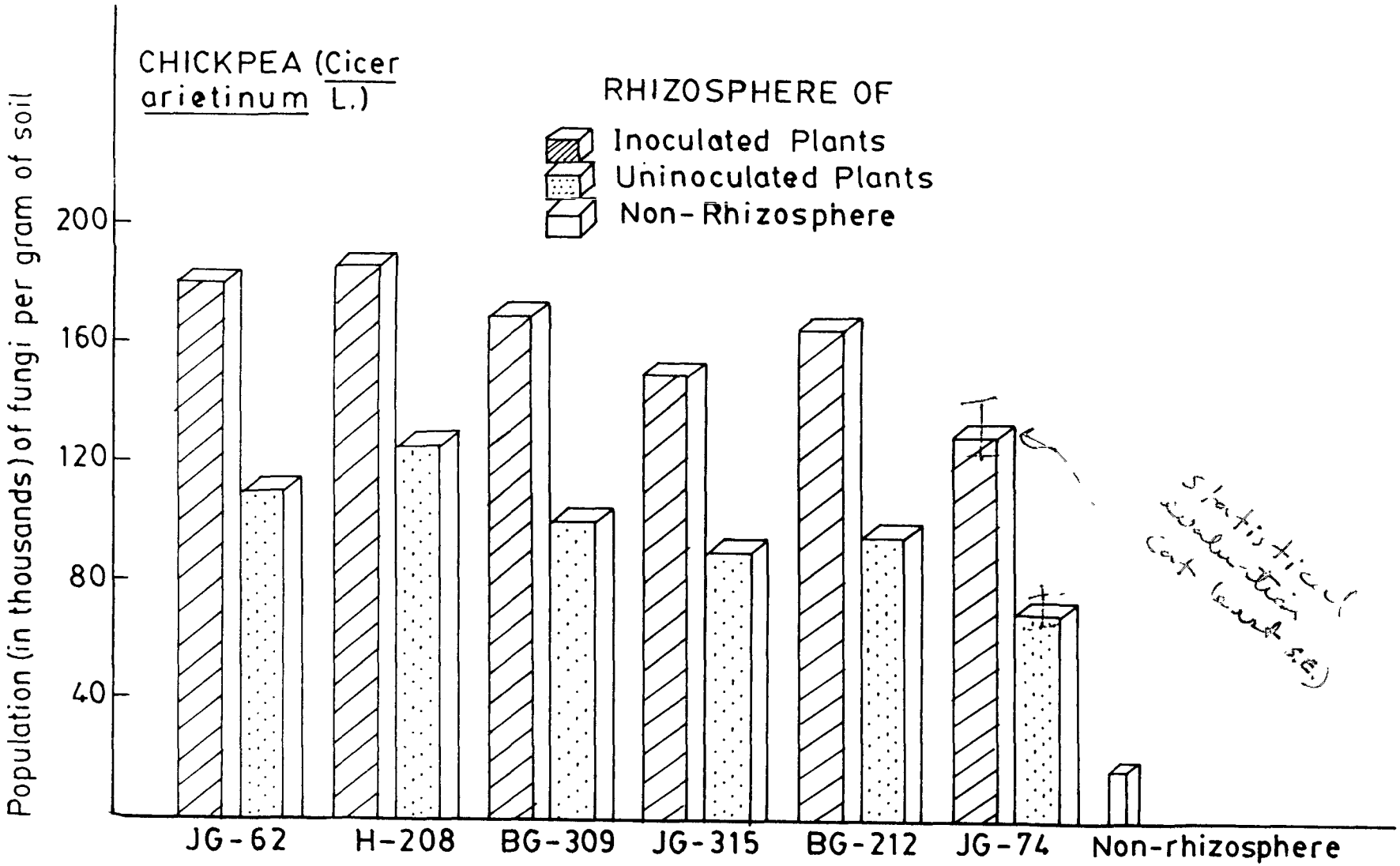
CHICKPEA (Cicer arietinum L.)
RHIZOSPHERE OF
Inoculated Plants
Uninoculated Plants
Non-Rhizosphere
Population (in thousands) of fungi per gram of soil
200
160
120
80
40
JG-62
H-208
BG-309
JG-315
BG-212
JG-74
Non-rhizosphere
CULTIVARS

Fig.1

TABLE - 1: Population of fungi (per gram of soil) in different chickpea cultivars uninoculated and those inoculated with *Fusarium oxysporum* f.sp. *ciceri*

Caltivars	POPULATION			
	Inoculated Plants	R:S	Uninoculated Plants	R:S
Non-rhizosphere	17+		17	
JG-62	180	10.58	110	6.47
H-208	185	10.88	125	7.35
BG-309	170	10.00	100	5.88
BG-212	150	8.82	90	5.29
JG-315	165	9.70	95	5.59
JG-74	130	7.64	70	4.11
L.S.D. at 5%	1.7888863		1.9651918	
L.S.D. at 1%	2.5444259		2.7951942	

+in thousands

Needs multiple comparison to show signif. diffs.

TABLE - 2: Concentrations (in mg/100 mg of dry samples) of free amino acids, phenols, O-dihydroxy phenols and sugars in the roots of different chickpea cultivars uninoculated and those inoculated with Fusarium oxysporum f.sp. ciceri

Cultivars	Free amino acids		Phenols		O-dihydroxy phenols		Sugars	
	IP	UP	IP	UP	IP	UP	IP	UP
JG-62	0.45	0.30	1.30	0.90	0.185	0.145	2.90	2.15
H-208	0.60	0.35	1.60	1.15	0.165	0.120	2.70	1.95
BG-309	0.70	0.50	2.70	1.90	0.280	0.200	2.50	1.75
JG-315	0.90	0.75	3.30	2.10	0.300	0.205	2.40	1.40
BG-212	1.05	0.80	3.60	2.50	0.375	0.265	1.35	1.05
JG-74	1.25	1.00	3.75	2.50	0.425	0.305	1.55	1.20
L.S.D. at 5%	0.095398	0.073500	0.098249	0.098244	0.0099638	0.0095309	0.098244	0.093
L.S.D. at 1%	0.135690	0.104543	0.139752	0.139738	0.014172	0.0302034	0.139973	0.133

IP = Inoculated plants

UP = Uninoculated plants

Need statistical comments

TABLE - 3: Amino acids present in the roots of different chickpea cultivars uninoculated and those inoculated with *Fusarium oxysporum* f.sp. *ciceri*

Amino acids	CULTIVARS										
	JG-62		H-208		BG-309		JG-315		BG-212		JG-
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP
Alanine	+	+	+	+	+	+	+	+	+	+	+
Asparagine	+	+	+	+	+	+	+	+	-	-	-
Aspartic acid	+	+	+	+	+	+	+	+	+	+	+
Glutamic acid	+	+	+	+	+	+	+	+	+	+	+
Glycine	+	+	+	+	+	+	+	+	+	+	+
Histidine	+	+	+	+	+	+	+	+	-	-	-
Leucine	-	-	-	-	-	-	+	+	-	-	-
Lysine	+	+	+	+	+	+	+	+	-	-	-
Phenylalanine	+	+	+	+	+	+	-	-	+	+	+
Proline	+	+	+	+	+	+	-	-	-	-	-
Serine	-	-	+	+	+	+	+	+	+	+	+
Tryptophane	+	+	+	+	+	+	-	-	-	-	-
Tyrosine	-	-	-	-	-	-	+	+	+	+	+
Valine	+	+	+	+	+	+	-	-	-	-	-
Cysteine	-	-	-	-	-	-	-	-	+	+	+

IP = inoculated plants, UP = uninoculated plants.

TABLE - 4: Frequency (percentage) of fungi in the rhizosphere of different chickpea cultivars [illegible] of [illegible] and those inoculated with *Fusarium oxysporum* f. sp. *ciceri*

Fungi Isolated	CULTIVARS											
	JG-62		H-208		BG-309		JG-315		BG-212		[illegible]-74	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Rhizopus oryzae	20	30	10	20	20	25	15	25	10	30	-	25
R. nodosus	-	-	10	20	5	20	10	15	-	-	10	15
Cunninghamella verticillatae	-	-	-	-	20	-	20	10	15	-	-	-
C. echinulata	20	5	25	15	30	15	-	-	30	10	25	-
Mucor racemosus	25	-	15	-	20	-	15	-	-	-	-	-
M. globosus	-	-	-	-	-	-	-	-	15	-	20	10
Mortierilla alpina	25	-	25	-	-	-	-	-	-	-	10	-
Monilia humicola	30	20	-	-	-	-	35	20	20	10	25	15
Cephalosporium aspermum	10	20	15	25	-	-	-	20	-	-	-	25
Syncephalastrum racemosum	15	-	20	-	-	-	-	-	30	-	-	-
Chaetomium flavum	15	20	15	30	20	20	25	10	15	-	20	-
Macrophomina phaseolina	20	-	-	-	15	-	10	-	-	-	-	-
Phoma hibernica	-	-	-	25	-	20	-	15	-	20	-	10
Aspergillus fumigatus	35	25	25	20	25	20	45	45	40	35	10	30
A. flavus	20	25	35	40	25	40	60	65	55	65	25	35
A. niger	20	40	30	55	25	55	35	45	35	60	20	45
A. terreus	-	20	-	-	10	25	15	30	-	35	20	40
A. luchuensis	-	20	-	25	-	-	-	-	-	-	-	30
A. funiculosus	-	20	10	25	10	20	-	-	15	30	-	-
A. condidus	15	-	20	-	20	-	-	-	20	-	15	-
A. flavipes	30	20	20	10	-	-	-	-	-	-	25	-
A. sparsus	10	25	-	30	-	20	-	-	-	-	-	30
A. clavatus	-	-	-	-	15	30	-	-	20	35	10	20
A. ochraceous	-	-	-	-	-	-	-	-	-	10	-	-
Penicillium notatum	-	-	10	20	15	30	-	-	-	25	20	35
Gliocladium roseum	-	-	-	-	-	-	-	-	-	-	25	35
Monosporium olivaceum	15	-	25	-	30	-	20	-	10	-	15	-
Botrytis cinerea	20	-	15	-	-	-	-	-	5	-	-	-
Torulla alji	-	20	-	15	-	20	-	-	-	-	-	25
Sepdonium chrysospermum	15	-	30	-	20	-	20	-	15	-	-	-
Botryotrichum pulluliferum	-	-	-	-	20	30	10	15	-	-	-	-
Verticillium glaucum	-	-	10	-	-	-	15	5	20	10	25	-
Cladosporium herbarum	30	20	35	20	35	30	30	25	25	20	30	25
Humicola fuscotra	-	25	-	10	-	20	-	30	-	25	-	15
Memnoniella echnidata	-	25	-	15	15	20	-	15	10	20	15	30
Drechslera hawaiensis	35	30	40	35	40	30	30	25	40	30	40	30
D. nodosus	-	-	30	10	-	-	-	-	-	-	-	-
Alternaria alternata	30	15	25	-	15	-	20	-	10	-	20	-
A. humicola	-	-	-	20	-	15	-	20	15	10	-	20
A. fusiculata	-	-	20	-	20	-	20	-	-	-	-	-
Curvularia lunata	25	15	30	10	35	20	50	35	45	30	40	30
C. geniculata	-	-	-	-	-	-	-	-	25	15	-	-
Fusarium roseum	-	-	-	-	-	-	-	20	-	25	-	-
F. moniliformae	-	20	-	-	-	35	-	-	-	-	-	-
F. oxysporum	-	35	-	25	15	20	15	25	-	-	-	-
F. oxysporum f.sp. *ciceri*	60	-	55	-	50	-	40	-	45	-	35	-
Acrophialophora fusipora	10	10	-	-	-	-	-	-	-	-	-	-
Trichoderma viridae	-	25	-	25	-	30	-	35	15	40	10	35
T. lignorum	-	-	-	-	-	20	15	20	-	15	10	15
Hematogonium humicola	-	-	-	-	-	-	25	-	-	-	-	-
Rhizoctonia solani	20	-	15	-	-	-	-	-	5	-	-	-
Sclerotium rolfsii	15	-	10	-	20	-	10	-	5	-	15	-
Brown sterile mycelium	25	-	10	-	15	-	15	-	20	-	20	-
Black sterile mycelium	-	25	-	15	-	10	-	30	-	40	-	15
White sterile mycelium	10	-	15	15	10	10	25	-	-	-	-	-

IP - Inoculated plants; UP - Uninoculated plants.

S.E

TABLE - 5: Frequency (percentage) of fungi in the rhizoplane of different chickpea cultivars uninoculated and those inoculated with *Fusarium oxysporum* f.sp. *ciceri*

Fungi isolated	CULTIVARS											
	JG-62		H-208		BG-309		JG-315		BG-212		JG-74	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Rhizopus oryzae	25	35	10	30	15	25	15	30	20	30	-	30
R. nodosus	-	-	10	25	15	30	10	20	-	-	10	15
Cunninghomella echinulata	20	5	20	10	25	15	-	-	30	20	20	-
Mucor racemosus	20	-	10	-	15	-	15	-	-	-	10	-
Mortierilla alpina	20	-	15	-	-	-	-	-	-	-	10	-
Monilia humicola	-	-	-	-	-	-	30	20	25	10	-	-
Cephalosporium aspermum	-	30	-	25	-	-	-	30	-	-	-	20
Chaetomium flavum	15	25	15	30	20	25	10	20	-	-	-	-
Aspergillus fumigatus	30	20	40	30	25	25	40	30	50	40	40	30
A. flavus	25	40	40	50	25	40	50	60	40	70	30	45
A. niger	20	35	30	50	15	40	25	60	35	70	35	40
A. terreus	-	20	-	10	-	30	-	25	-	25	-	30
A. luchuensis	-	20	-	30	-	-	-	-	-	-	-	-
A. candidus	-	-	30	-	35	-	-	-	25	-	-	-
A. clavatus	-	-	-	-	-	-	-	-	20	30	20	35
A. sparsus	15	20	-	25	-	20	-	-	-	-	-	20
A. flavipes	25	15	30	10	-	-	-	-	-	-	-	-
Gliocladium roseum	-	-	-	-	-	-	-	-	-	-	35	25
Monosporium olivaceum	10	-	40	-	35	-	20	-	20	-	15	-
Botrytis cinerea	20	-	15	-	-	-	-	-	-	-	-	-
Cladosporium herbarum	20	15	25	15	30	20	25	15	15	10	30	20
Memnoniella echinata	-	30	-	15	10	20	-	15	15	20	-	25
Drechslera hawaiensis	20	15	40	20	35	25	40	25	45	35	25	15
Curvularia lunata	35	25	30	15	20	10	25	10	40	20	35	25
Alternaria alternata	20	10	15	-	15	-	20	-	15	-	10	-
Fusarium oxysporum f.sp. *ciceri*	60	-	60	-	55	-	50	-	45	-	40	-
Acrophialophora fusipora	15	10	-	-	-	-	-	-	-	-	-	-
Trichoderma viridae	-	25	-	20	-	25	-	35	10	40	10	35
Torulla allii	-	-	-	15	-	25	-	-	-	-	-	-
Sepdonium chrysospermum	-	-	20	-	15	-	10	-	5	-	-	-
Humicola fuscotra	-	25	-	-	-	-	-	15	-	20	-	15
Rhizoctonia solani	20	-	15	-	-	-	-	-	-	-	-	-
Sclerotium rolfsii	15	-	10	-	20	-	15	-	15	-	10	-
Sterile brown mycelium	20	-	20	-	-	-	25	-	-	-	25	-
Sterile black mycelium	-	20	-	30	-	30	-	25	-	45	-	30

IP = Inoculated plants; UP = Uninoculated plants

3.2 EFFECT OF AGE OF CHICKPEA CULTIVAR JG-62 ON THE RHIZOSPHERE MYCOFLORA INOCULATED WITH FUSARIUM OXYSPORUM F.SP. CICERI

Out of 45 fungal species isolated, the number of fungi from rhizosphere of inoculated plants was 34 as against 24 and 30 from non-rhizosphere zone and the rhizosphere of uninoculated plants respectively (Table-8). As a result of inoculated, differences were observed in the rhizosphere mycoflora Mucor racemosus, Cunninghamella echinulata, Mortierilla alpina Macrophomina phasiolina, Syncephalastrum racemosum, Aspergillus candidus, Botrytis cinerea, Monosporium olivaceum, Rhizoctonia solani and sterile bronw mycelium were confined to the rhizosphere of inoculated plants in addition to Fusarium oxysporum f.sp. ciceri with which the plants were inoculated and Aspergillus terreus, Botryotrichum piluliferum and sterile black mycelium in the rhizosphere of uninoculated plants whereas Geotrichum candidum, Aspergillus koningi and sterile white mycelium in the non-rhizosphere area.

The number of fungi in the rhizosphere of both inoculated and uninoculated plants increased with the increase in the age of plants upto 60 days followed by a decline with more fungi in inoculated plants (Table-8). Aspergillus fumigatus, A. flavus, A. niger, Monilia humicola and Cladosporium herbarum were recorded throughout the growth period in the rhizosphere of

both inoculated and uninoculated plants. Aspergillus funiculosus, Fusarium oxysporum and Trichoderma viridae were isolated in the early part of growth period, Aspergillus sparsus, Rhizopus oryzae, Acrophialophora fusipora and Alternaria alternata from early to intermediate growth period; Cephalosporium aspermum, Aspergillus okazakii, A. flavipes and Trichosporium fuscum during intermediate growth stage; Chaetomium flavum, Drechslera hawaiensis, Curvularia lunata from intermediate to later part of growth period and A. funiculosus and Spicaria silvatica in the later part of growth period. from rhizosphere of both inoculated and uninoculated plants. In the rhizosphere of inoculated plants Mucor racemosus, C. echinulata, A. flavipes, Mortierilla alpina F. oxysporum f.sp. ciceri, A. alternata and sterile brown mycelium were recorded throughout the growth period; P. lilacinum in the early growth period; A. candidus, S. racemosum from early to intermediate growth stages; B. cinerea during intermediate growth stage; M. phasiolina, S. rolfsii and S. chrysospermum from intermediate to later part of the growth period and R. solani in later part of growth period, while from the rhizosphere of uninoculated plants A. luchuensis, T. allii, M. echinata and sterile black mycelium at all the intervals of growth period; P. piluliferum in the early part; Fusarium moniliformae during intermediate and A. terreus, and Humicola fuscotra from intermediate to later part of growth period.

There was increase in frequency of most of the fungi in the rhizosphere of both inoculated and uninoculated plants with the increase in age upto a certain period followed by a decline. In some cases there was again an increase. However, in the non-rhizosphere no definite pattern of frequency of different fungi was observed. In the rhizosphere of inoculated plants frequency of certain fungi exhibited a decline with increase in age of plants. These fungi include R. oryzae, A. flavus, A. niger and D. hawaiensis. Frequency of F. oxysporum f.sp. ciceri in the rhizosphere of inoculated plants increased with the increase in age of plant upto 75 days then slightly decreased with onset of senescence. In the rhizosphere of inoculated plants, the frequency of most of the saprophytic fungi decreased with the increase in age of plant, however the reverse was true with the parasitic fungi. The frequency of saprophytic fungi was higher in the rhizosphere of uninoculated plants while that of parasitic fungi in the rhizosphere of inoculated plants.

The number of fungi on the rhizoplane of chickpea plants inoculated and uninoculated was slightly less than corresponding rhizosphere and it was 27 and 24 fungal species respectively (Table-9). The number of fungi in the rhizoplane also increased with the increase in age of plant upto a stage after which there was a decrease. Not all fungi were isolated from rhizoplane at

all the stages of plant growth. Aspergillus funigatus, A. flavus, A. niger and Cladosporium harbarum were recorded in the rhizoplane of both inoculated and uninoculated plants at all the stages of the growth of plant. However, other fungi were present at certain stages of plant growth only. Mucor racemosus, Cunninghamella echinulata, Aspergillus funiculasus, Alternaria alternata and Acrophialophora fusipora were isolated from early part of growth of plant Rhizopus oryzae, Aspergillus sparsus from early to middle age Sclerotium rolfsii in the middle age; Curvularia lunata, Drechslera hawaiensis and Aspergillus ochroaceous from middle to last stages of plant growth in the rhizoplane of both inoculated and uninoculated plants. However, in the rhizoplane of inoculated plants Monosporium olivaceum, Macrophomina phasiolina and Fusarium oxysporum f.sp. ciceri at all stages of plant growth; Botrytis cinerea, Mucor racemosus in the middle age of growth of plant and Alternaria alternata, Rhizoctonia solani and Sclerotium rolfsii in the last phases of growth of plant. In the rhizoplane of uninoculated plants Memnoniella echinata, Aspergillus luchuensis, sterile black mycelium were recorded at all the stages of growth of plant; Aspergillus terreus, Humicola fuscotra, Trichoderma viridae and Cephalosporium aspermum from middle to last phases of growth of plant and R. oryzae and A. funiculosus. In the later stages of plant growth, M. alpina, M. phasiolina, B. cinerea, M. olivaceum, R. solani

and sterile brown mycelium were exclusively present in the rhizoplane of inoculated plants and A. luchuensis, A. terreus Fusarium oxysporum, M. echinata, Cephalosporium aspermum H. fuscotra and sterile black mycelium in that of uninoculated plants only.

For most of the fungi, the frequency increased with increase in age of plants upto 60 days followed by a decline. However, in the rhizoplane of uninoculated plants the frequency of A. flavus increased upto senescence. In the rhizoplane of inoculated plants certain fungi such as A. fumigatus, A.flavus and A. niger exhibited a decline with increase in age of plants. The frequency of F. oxysporum f.sp. ciceri in the rhizoplane of inoculated plants increased with increase in age of plants upto 75 and then remaine constant. In the rhizoplane of inoculated plants, the frequency of most of the saprophytic forms decreased with the increase in age of the plant however, the reverse was true with the parasitic fungi.

The population of fungi in the rhizosphere of inoculated and uninoculated plants also increased in age of plant upto 75 days followed by decline (Table-6). In inoculated plants, however, there was again an increase at 120-days-old plants. The population of fungi was high in the rhizosphere of inoculated plants as compared to uninoculated ones.

When compared with non rhizosphere mycoflora the R:S ratio increased with increase in the age of plant upto 90 days in inoculated plants as against 75 days in uninoculated plants (Table-6). However, highest R:S ratio in inoculated plants was at 120 days old. Thus the inoculated plants provide more favourable environment for the rhizosphere fungi.

Quantitative analysis of the root extracts indicated that the concentration of free amino acids (Mg/100 mg of dry sample) varied at different stages of plant growth (Table- 7). It also exhibited an increase upto certain stage of plant growth followed by decline in both root extracts of inoculated and uninoculated plants. A similar trend was observed with total phenols, O-dihydroxyphenols and sugar contents in the roots' extracts of both inoculated and uninoculated plants. The concentration of free amino acids, phenols, O-dihydroxyphenols and sugars was high in the roots of inoculated plants as compared to uninoculated ones.

FIG. 2. Population of fungi in the non-rhizosphere, rhizosphere of uninoculated and inoculated plants of chickpea (with Fusarium oxysporum f.sp. ciceri) at varying age of the plant.

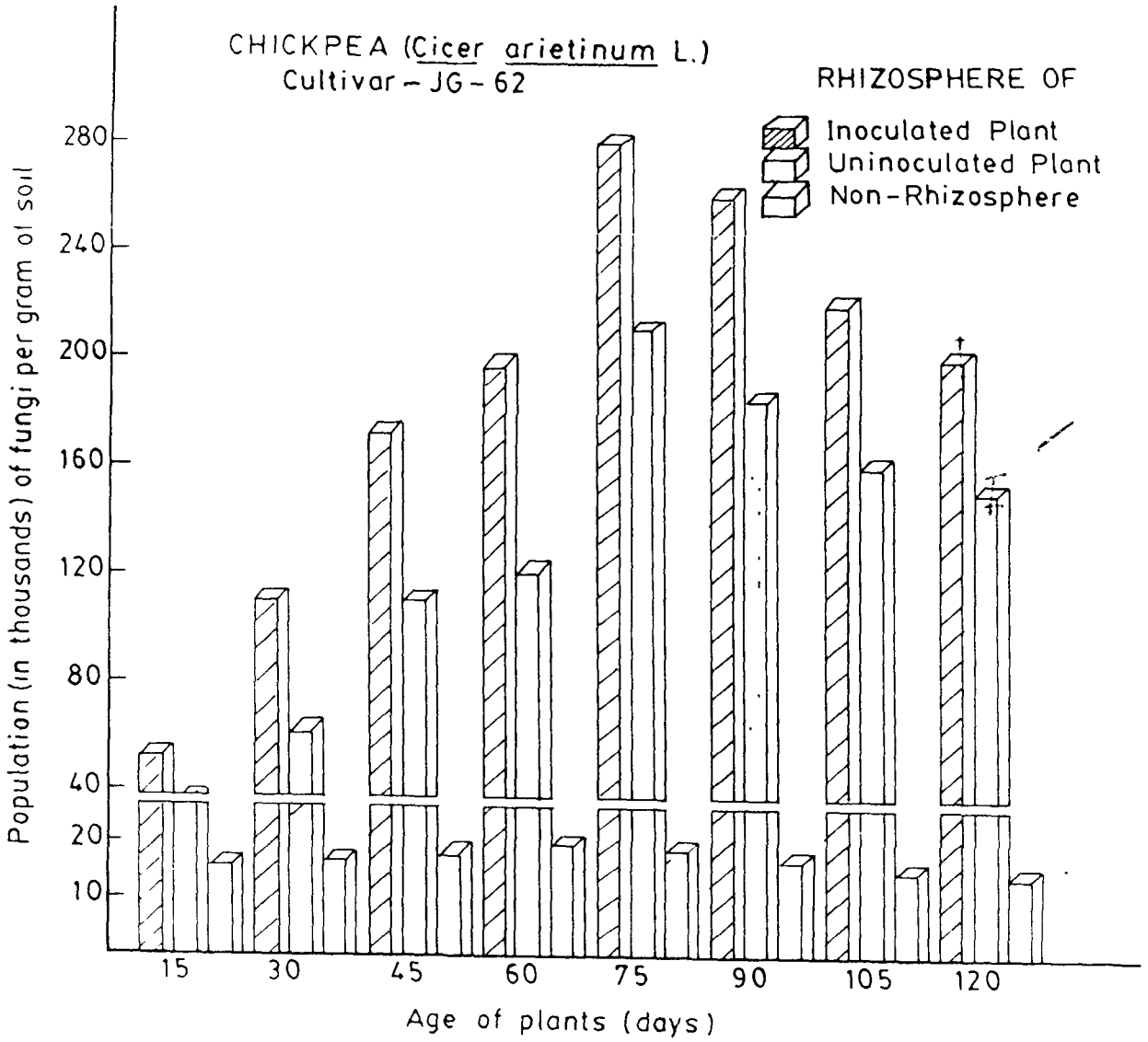
CHICKPEA (Cicer arietinum L.)
Cultivar – JG – 62
RHIZOSPHERE OF
Inoculated Plant
Uninoculated Plant
Non-Rhizosphere
Population (in thousands) of fungi per gram of soil
280
240
200
160
120
80
40
20
10
15
30
45
60
75
90
105
120
Age of plants (days)

Fig. 2

TABLE - 6: Population of fungi (per gram of soil) in non-rhizosphere, rhizosphere of uninoculated and those inoculated with Fusarium oxysporum f.sp. ciceri of chickpea plant cultivar JG-62 at varying age

Age of plants (days)	Non-rhizosphere(S)	RHIZOSPHERE (R)			
		Inoculated Plants	R:S Ratio	Uninoculated Plants	R:S Rat:
15	16+	51	3.18	34	2.12
30	17	110	4.23	61	3.58
45	18	172	6.11	110	4.61
60	20	196	9.80	120	6.00
75	19	280	14.73	210	11.05
90	17	260	15.29	185	10.88
105	15	220	13.33	160	10.66
120	14	200	15.71	150	10.71
L.S.D. at 5%	1.7669531	1.7038271		1.8576244	
L.S.D. at 1%	3.2760712	3.1590305		3.444183	

+in thousands

Needs statistical comparisons (multivariate) multiple regression, linear programs?

TABLE - 7: Concentration (in mg/100 mg of dry sample) of free amino acids, phenols, O-dihydroxy-phenols, sugars in the roots of chickpea plant cultivar JG-62 uninoculated and those inoculated with Fusarium oxysporum f.sp. ciceri at varying age

Age of Plant	Free amino acids		Phenols		O-dihydroxyphenols		Sugars	
	IP	UP	IP	UP	IP	UP	IP	UP
30	0.28	0.19	0.75	0.40	0.10	0.08	2.45	1.90
45	0.40	0.25	1.15	0.85	0.175	0.125	2.75	2.20
60	0.76	0.45	1.70	1.35	0.295	0.225	3.55	2.60
75	0.95	0.62	1.85	1.55	0.325	0.245	3.65	2.85
90	0.82	0.70	1.65	1.20	0.250	0.145	3.30	2.50
105	0.76	0.60	1.25	1.05	0.175	0.110	3.00	2.10
120	0.64	0.50	0.95	0.95	0.135	0.100	2.80	1.95
L.S.D. at 5%	0.0316297	0.0346473	0.0228919	0.0216613	0.0023347	0.0020729	0.847202	0.068303
L.S.D. at 1%	0.0435804	0.0477381	0.0315412	0.0298456	0.0032168	0.0028561	0.1167301	0.094109

TABLE - 8 [illegible] of fungi in the rhizosphere of [illegible] plant (cultivar JG-62) uninoculated and those inoculated with [illegible] *Fusarium* f.sp. *ciceri* at varying [illegible]

Fungi isolated	15			30			45			60			75			90			105			120		
	R		NR	R		NR	R		NR	R		NR	R		NR	R		NR	R		NR	R		NR
	IP	UP		IP	UP		IP	UP		IP	UP		IP	UP		IP	UP		IP	UP		IP	UP	
Rhizopus oryzae	30	35	35	25	30	25	20	30	35	[illegible]	[illegible]	30	-	[illegible]	20	-	25	-	-	15	-	-	15	-
Mucor racemosus	6	-	-	15	-	-	15	-	-	6	-	-	10	-	-	10	-	-	15	-	-	-	-	-
Cunninghamella echinulata	20	-	15	25	-	20	30	-	20	[illegible]	-	25	20	-	15	10	-	-	-	-	-	10	-	-
Mortierella alpina	10	-	10	10	-	10	15	-	15	5	-	10	20	-	10	10	-	-	-	-	-	-	-	-
Geotrichum candidum	-	-	20	-	-	35	-	-	35	-	-	35	-	-	30	-	-	30	-	-	20	-	-	25
Monilia humicola	15	10	-	20	15	-	30	25	-	10	30	-	35	20	-	25	15	-	15	10	-	10	5	-
Cephalosporium [illegible]	-	-	-	15	10	-	10	15	-	5	25	-	-	20	-	-	10	-	-	-	-	-	-	-
Chaetomium flavum	-	-	-	-	-	-	20	20	-	20	35	15	35	20	10	40	15	-	40	10	-	40	10	10
Macrophomina phaseolina	-	-	-	15	-	-	20	-	-	20	-	-	25	-	-	25	-	-	20	-	-	15	-	-
Aspergillus fumigatus	40	40	20	40	30	25	40	25	20	40	30	20	40	30	20	35	30	20	30	20	25	20	25	15
A. flavus	40	20	10	35	20	10	25	30	15	30	50	10	20	0	20	10	60	25	20	70	35	20	75	30
A. niger	15	20	25	20	30	20	20	35	25	40	55	20	30	40	25	30	35	30	25	60	30	20	20	20
A. funiculosus	1		-	10	20	-	-	15	-	-	15	-	-	15	-	-	20	10	-		10	-	20	10
A. terreus	-	-	-	-	-	-	-	20	-	-	20	-	-	20	-	-	20	-	-	1	-	-	10	-
A. luchuensis		1	10	-	10	-	-	20	10	-	0	-	-	25	-	-	15	-	-	10	-	-	10	-
A. candidus	10	-	-	10	-	-	15	-	-	[illegible]	-	-	15	-	-	5	-	-	-	-	-	-	-	-
A. okazakii		-	-	-	-	-	-	-	-	-	-	-	[illegible]	30	-	10	30	-	-	2	-	-	20	-
A. flavipes		-	-	25	-	-	30	10	-	35	20	-	25	15	-	30	-	-	35	-	-	30	-	-
A. sparsus	6	15	10	20	25	-	20	25	10	5	30	15	10	40	20	-	25	-	-	-	-	-	10	-
A. [illegible]oningi		-	10	-	-	15	-	-	20	-	-	25	-	-	20	-	-	25	-	-	20	-	-	15
Penicillium lilacinum		-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-
Botrytis cinerea	-	-	-	-	-	-	15	-	-	20	-	-	20	-	-	10	-	-	-	-	-	-	-	-
Torulla allii	-	15	-	-	15	-	-	20	10	-	25	-	-	20	20	-	25	20	-	15	15	-	10	10
Monosporium olivaceum	10	-	-	10	-	-	15	-	-	20	-	-	20	-	-	15	-	-	15	-	-	15	-	-
Sepdonium chrysospermum	-	-	-	-	-	-	-	-	-	15	-	-	20	-	-	30	-	20	20	-	20	25	-	10
Botryotrichum piluliferum	-	15	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladosporium herbarum	20	10	-	20	20	-	30	25	-	40	30	-	35	30	-	30	20	-	30	25	-	20	10	-
Spicaria silvatica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	15	-	25	20	-	20	20	-
Syncephalastrum racemosum	10	-	-	20	-	-	25	-	-	35	-	-	30	-	-	15	-	-	-	-	-	-	-	-
Trichosporium fuscum	-	-	-	-	-	-	-	-	-	30	20	-	20	15	-	15	10	-	-	-	-	-	-	-
Humicola fuscora	-	-	-	-	-	-	-	15	-	-	20	-	-	25	10	-	20	20	-	10	5	-	15	5
Memnoniella echinata	-	10	-	-	15	-	-	20	-	-	25	10	-	25	15	-	20	15	-	20	10	-	20	-
Drechslera hawaiensis		-	-	-	-	15	35	30	20	35	30	20	30	20	15	25	15	10	20	10	10	20	10	10
Curvularia lunata	-	-	-	-	-	-	20	20	-	25	20	-	30	25	-	25	10	-	25	10	-	30	10	-
Alternaria alternata	5	10	15	20	10	20	25	20	-	30	20	-	35	10	-	15	-	-	10	-	-	-	-	-
Fusarium moniliiforme		-	-	-	-	-	-	20	-	-	25	-	-	15	-	-	15	-	-	-	-	-	-	-
F. oxysporum	5	25	15	10	25	20	-	25	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-
F. oxysporum f.sp. ciceri	5	-	-	45	-	-	50	-	-	65	-	-	80	-	-	70	-	-	60	-	-	60	-	-
Acrophialophora fusispora	15	10	10	20	10	15	25	15	-	30	15	-	15	-	-	-	-	-	-	-	-	-	-	-
Trichoderma viride	10	25	-	-	30	-	-	30	-	-	35	-	-	30	-	-	25	-	-	25	-	-	25	-
Rhizoctonia solani		-	-	-	-	-	15	-	10	20	-	-	-	-	-	15	-	-	10	-	-	10	-	-
Sclerotium [illegible]		-	-	-	-	-	10	-	-	15	10	-	20	-	-	10	-	-	10	-	-	10	-	-
White [illegible]		-	10	-	-	15	-	-	20	-	-	15	-	-	15	-	-	10	-	-	10	-	-	1
[illegible] brown	10	-	-	15	-	-	25	-	-	20	-	-	10	-	-	10	-	-	15	-	-	20	-	-
[illegible]		10	-	-	15	-	-	20	-	-	30	-	-	25	-	-	20	-	-	25	-	-	[illegible]	-

R [illegible] sphere

IP [illegible] uninoculated plants

Statistics (S.E. et Limit)

TABLE - 9: Frequency (percentage) of fungi in the rhizoplane of chickpea plants (cultivar JG-62) uninoculated and those inoculated with Fusarium oxysporum f.sp. ciceri at varying age

	DAYS															
	15		30		45		60		75		90		105		120	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Rhizopus oryzea	25	15	30	25	35	30	25	40	15	45	-	35	-	25	-	15
Cunninghamella echinulata	15	10	20	5	25	-	30	-	20	-	10	-	15	-	10	-
Mucor racemosus	10	10	20	10	25	-	25	-	20	-	10	-	-	-	-	-
Mortierilla alpina	10	-	15	-	20	-	20	-	15	-	10	-	-	-	-	-
Macrophomina phaseolina	-	-	10	-	15	-	20	-	20	-	15	-	15	-	10	-
Chaetominum flavum	-	-	10	15	20	20	20	25	30	25	30	10	25	10	15	10
Aspergillaus fumigatus	45	40	45	40	35	25	50	30	40	30	40	30	30	25	20	20
A. flavus	35	35	30	40	25	40	25	55	20	60	20	65	25	65	25	70
A. niger	20	25	25	30	20	30	20	35	20	40	15	30	10	25	10	20
A. terreus:	-	-	-	-	-	15	-	25	-	20	-	20	-	15	-	10
A. luchuensis	-	10	-	15	-	20	-	25	-	15	-	10	-	10	-	20
A. okazakii	-	-	-	-	-	-	-	-	15	30	10	25	-	20	-	10
A. funiculosus	20	20	15	10	-	-	-	-	-	15	-	10	-	15	-	25
A. flavipes	10	-	15	-	20	15	30	-	25	-	30	-	30	-	35	-
A. ochraceous	-	-	-	-	-	-	-	-	15	20	20	30	25	45	20	35
A. sparus	10	15	15	20	15	25	20	30	10	15	-	5	-	-	-	-
Botrytis cinerea	-	-	-	-	15	-	20	-	10	-	-	-	-	-	-	-
Memnoniella echinata	-	10	-	10	-	20	-	30	-	25	-	15	-	15	-	10
Cladasporium herbarum	15	15	15	10	30	15	35	20	40	15	45	15	30	20	30	25
Drechslera hawaiensis	-	-	10	-	15	10	20	15	30	15	30	10	30	10	25	-
Curvularia lunata	-	-	15	-	15	10	20	15	30	25	40	30	40	35	40	40
Humicola fuscotra	-	-	-	-	-	10	-	15	-	15	-	10	-	5	-	-
Alternaria alternata	10	10	20	15	25	10	30	-	15	-	10	-	10	-	-	-
Trichoderma viridae	10	20	10	20	-	25	-	30	-	35	-	35	-	30	-	25
Fusarium oxysporum	-	25	-	15	-	10	-	-	-	-	-	-	-	-	-	-
Fusarium oxysporum f.ciceri	25	-	35	-	55	-	70	-	75	-	60	-	60	-	60	-
Monosporium olivaecum	10	-	10	-	25	-	30	-	30	-	25	-	20	-	15	-
Cephalosporium aspermum	-	-	-	15	-	20	-	30	-	25	-	25	-	10	-	10
Acrophialophora fusipora	10	10	15	10	20	15	-	10	-	-	-	-	-	-	-	-
Rhizoctonia solani	-	-	-	-	10	-	-	-	-	-	-	-	15	-	20	-
Sclerotium rolfsii	-	-	-	-	15	10	15	15	-	-	-	-	10	-	10	-
Sterile brown mycelium	10	-	15	-	25	-	30	-	20	-	15	-	20	-	15	-
Sterile black mycelium	-	15	-	25	-	30	-	20	-	10	-	-	-	-	-	-

IP = Inoculated plants, UP = Uninoculated plants.

Statistics (S.E. etc.)

3.3 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF CHICKPEA PLANTS (CULTIVAR JG-62 AND JG-74) INOCULATED WITH FUSARIUM OXYSPORUM F.SP.CICERI IN RELATION TO FOLIARY SPRAY

(a) Growth Regulator:

Results presented in Tables 12 and 16 show that as a result of spray of plants with growth promoting substances, the number of fungi in the rhizosphere increased with the increase the number of sprays. The number of fungi in the rhizosphere was also more in those inoculated with F. oxysporum f.sp. ciceri. In amongst the two varieties tested the highest number of fungi was reported from the rhizosphere of JG-62 both in inoculated and those uninoculated. When sprayed with indole acetic acid, the number of fungi in JG-62 was 20, 26, 29 in inoculated as against 19, 25, 27 in uninoculated after respective sprays; with indole butyric acid 21, 26, 29 in inoculated as against 21, 24, 27 in uninoculated with thio indole butyric acid 19, 27, 29 in inoculated as against 19, 26, 28 in uninoculated; with gibberellic acid 19, 26, 29 in inoculated as against 20, 24, 27 in uninoculated, and with maleic hydrazide 18, 24, 26 in inoculated as against 17, 23, 26 in uninoculated plants in respective sprays. The number of fungi as a result of spray with water as a control was 19, 26, 29 in inoculated as against 19, 24, 27 in uninoculated plants. With JG-74, the corresponding values were 22, 28, 28 in inoculated as against

22, 26, 27 in uninoculated when sprayed with indole acetic acid 21, 27, 28 as against 21, 25, 23 with indole butyric acid, 21, 28, 28 as against 21, 26, 27 with thio-indole butyric acid, 22, 28, 28 as against 21, 26, 27 with gibberellic acid, and 21, 26, 25 as against 18, 25, 27 with maleic hydrazide while the number of fungi in the rhizosphere of plants sprayed with water as control was 21, 26, 28 as against 19, 25, 27 in uninoculated plants. A similar trend was observed in the increase in the number of fungi with number of sprays was obtained in the rhizoplane with more number of fungi in those inoculated with F. oxysporum f.sp. ciceri (Tables, 14 and 18). In amongst the two cultivars tested, number of fungi was more in the rhizoplane of the JG-62 both in inoculated and uninoculated plants. When sprayed with indole acetic acid, the number of fungi was 17, 20, 23 in the rhizoplane of inoculated plants of JG-62 as against 16, 19, 20 in respective sprays in uninoculated, with indole butyric acid 17, 21, 23 in inoculated as against 15, 19, 20 in uninoculated plants; with thio indole butyric acid 17, 20, 23 in inoculated as against 15, 19, 20 in uninoculated plants, with gibberellic acid 17, 20, 23 in inoculated as against 15, 19, 20 in uninoculated plants, and with maleic hydrazide 15, 18, 21 in inoculated as against 15, 19, 17 in uninoculated with respective sprays. With water as control, the number was 15, 20, 23 in inoculated as against 15, 19, 20 in uninoculated plants. With cv. JG-74 the corres-

ponding values were 15, 19, 20 as against 14, 18, 19 when sprayed with indole butyric acid; 15, 19, 20 as against 14, 18, 19 with indole butyric acid 15, 19, 20 as against 14, 18, 19 with thio-indole butyric acid; 15, 19, 20 as against 14, 18, 19 with gibberellic acid; and 14, 17, 19 as a against 14, 18, 18 with maleic hydrazide. The number of fungi was 15, 18, 20 as against 14, 18, 19 after respective sprays with water. The number of fungi was less in rhizoplane as compared to rhizosphere. It appears there has not been material effect on the number of fungi both in rhizosphere and rhizoplane as a result of sprays with different growth promoting substances. By and large the population of fungi in the rhizosphere increased due to sprays with growth promoting substances and highest increase was observed when sprayed with indole acetic acid in inoculated plants (Table 10 and 11). In uninoculated as compared to inoculated ones there was less increase when compared with plants sprayed with water.

In general there was increase in the frequency as a result of sprays with growth promoting substances in the rhizosphere of JG-62 inoculated plants (Table 12 and 16) with spray of indole acetic acid highest increase in frequency of fungi was that of Macrophomina phaseolina followed by Monosporium olivaceum, Cladosporium herbarum, Fusarium oxysporium f.sp. ciceri, Aspergillus flavipes and Alternaria

alternata. However, in uninoculated plants the highest increase in the frequency was that of Cephalosporium aspermum, followed by Aspergillus niger, Spicaria silvatica, Rhizopus oryzae and Monilia humicola with indole butyric acid highest increase in frequency of fungi was that of M. phaseolina followed by F. oxysporium f.sp. ciceri, Sclerotium rolfsii R. oryzae, Mortierilla alpina, Syncephalastrum racemosum, Aspergillus fumigatus, A. flavus in inoculated and that of Chaetomium flavum followed by Curvularia lunata, Fusarium moniliformae and sterile black mycelium in uninoculated plants with thio indole butyric acid, R. oryzae followed by A. alternata, F. oxysporum f.sp. ciceri, sterile brown mycelium Rhizoctonia solani, C. lunata and M. olivacium in inoculated that of C. flavum followed by Aspergillus sparsus, A. flavipes, Humicola fuscotra, Curvularia geniculata and R. oryzae in uninoculated plants; with gibberllic acid F. oxysporum f.sp. ciceri followed by Mucor racemosus, S. rolfsii, A. flavipes, C. lunata, C. herbarum, S. racemosum and sterile brown mycelium in inoculated that of R. oryzae followed by A. fumigatus, A. flavus, A. terreus, A. luchuensis, C. herbarum, H. fuscotra, Memnoniella echinata, Drechslera hawaiensis and C. lunata in uninoculated plants; with maleic hydrazide the frequency of most of the fungi decreased, the frequency of M. racemosus decreased highest followed by C. herbarum, Aspergillus sparsus A. flavipes, A. candidus, C. aspermum, C. flavum, A. alternata,

and F. oxysporum f. ciceri inoculated that of A. fumigatus followed by A. flavipes, A. flavus, Acrophialophora fusipora in uninoculated plants, with an other variety JG-74 highest increase in the frequency was that of Mortierilla alpina followed by A. flavus, A. candidus, Penicillium notatum, S. rolfsii, T. viridae and sterile brown mycelium when sprayed with indole acetic in inoculated that of C. aspermum followed by Gliocladium roseum, Phoma hibernica, C. herparum and Trichoderma lignorum in uninoculated plants; with indole butyric acid highest increase in the frequency was that of Aspergillus clavatus followed by A. flavus, A. flavipes sterile brown mycelium and Mortierilla alpina in inoculated that of A. humicola followed by A. fumigatus, A. niger, T. viridae, H. fuscotra and sterile black mycelium in uninoculated plants; with thio indole butyric acid R. nodosus followed by A. flavus, A. fumigatus, A. niger, M. olivacium A. alternata, S. rolfsii and sterile brown mycelium in inoculated that of A. fumigatus followed by A. flavus, P. notatum, G. roseum H. fuscotra, P. hibernica and T. viridae and sterile black mycelium in uninoculated plants; with gibberellic acid M. globosus follwed by A. candidus, A. flavus, A. fumigatus, A. alternata, T. viridae, S. rolfsii and sterile brown mycelium in inoculated that of P. hibernica followed by A. clavatus, A. terreus, H. fuscotra, M. echinata, C. lunata, A. humicola and sterile black mycelium in

uninoculated plants. But with maleic hydrazide the frequency of M. racemosus, A. terreus and C. herbarum decreased most in inoculated that of P. hibernica, H. fuscotra and T. lignorum in uninoculated plants.

In the rhizoplane of JG-62, as a result of spray with indole acetic acid highest increase in the frequency was that of C. echinulata followed by F. oxysporum f.sp. ciceri, A. funigatus, A. flavipes, A. candidus, A. sparsus, B. cinerea, R. solani, A. fusipora, D. hawaiensis and sterile brown mycelium in inoculated and that of R. oryzae followed by C. aspermum, A. fumigatus, A. flavus, A. niger, A. terreus, A. luchuensis, A. flavipes, T. viridae, A. alternata and sterile black mycelium in uninoculated plants; with indole butyric acid highest increase in the frequency was that of R. oryzae followed by C. echinulata, M. phaseolina, F. oxysporum f.sp. ciceri, A. fumigatus, A. flavus, C. lunata and sterile brown mycelium in inoculated and that of A. fumigatus followed by C. herbarum, M. echinata, R. fuscotra, C. flavum, T. viridae, D. hawaiensis, C. lunata and sterile black mycelium in uninoculated plants; with thio indole butyric acid R. oryzae followed by A. alternata, S. rolfsii, A. fusipora, A. fumigatus, A. flavus and sterile brown mycelium, M. phaseolina, B. cinerea, C. lunata and F. oxysporum f.sp. ciceri in inoculated and that of A. fumigatus followed by H. fuscotra, C. aspermum, D. hawaiensis, C. lunata, M. echinata, C. herbarum, T. viridae

and A. flavus in uninoculated plants, with gibberellic acid M. phaseolina followed by M. alpina, R. solani, D. hawaiensis, A. alternata, C. lunata, F. oxysporum f.sp. ciceri, A. fumigatus A. flavus and sterile brown mycelium in inoculated and that of A. niger followed by A. alternata, C. lunata, M. echinata, C. herbarum, T. viridae, C. aspermum, A. fumigatus and A. flavus in uninoculated plants. But with maleic hydrazide frequency of A. niger decrease highest followed by M. phaseolina, S. rolfsii, R. solani, M. racemosus, C. flavum, C. echinulata, C. herbarum, M. olivaceum, A. alternata and F. oxysporum f.sp. ciceri in inoculated and that of A. flavipes followed by C. lunata, D. hawaiensis, A. alternata, A. fumigatus, A. luchuensis, A. sparsus, C. herbarum and sterile black mycelium in uninoculated plants (Table 14).

With an other variety JG-74, as a result of spray with indole acetic acid highest increase in the frequency was that of S. rolfsii followed by R. nodosus, M. globosus, C. echinulata, A. niger, F. oxysporum f.sp. ciceri, C. herbarum and sterile brown mycelium in inoculated and that of A. fumigatus followed by A. niger, A. flavus, C. aspermum, T. viridae, A. humicola, D. hawaiensis, C. lunata, A. sparsus, A. terreus, A. clavatus, M. echinata and sterile black mycelium in uninoculated plants; with indole butyric acid M. alpina followed by R. nodosus, M. globosus, A. fumigatus, A. niger, F. oxysporum f.sp. ciceri, D. hawaiensis, C. herbarum, and sterile bronw mycelium in

inoculated and that of A. fumigatus followed by A. niger, A. sparsus, H. fuscotra, R. oryzae, C. aspermum, M. echinata, D. hawaiensis, G. roseum, T. viridae and sterile black mycelium in uninoculated plants; with thio-indole butyric acid A. fumigatus followed by R. nodosus, T. viridae, M. olivaceum, C. lunata, D. hawaiensis, M. globosus, A. fumigatus, A. niger, C. herbarum, F. oxysporum f.sp. ciceri and sterile brown mycelium in inoculated plants and that of A. fumigatus followed by A. niger, A. flavus, C. herbarum, T. viridae, C. lunata, H. fuscotra, R. oryzae and sterile black mycelium in uninoculated plants; with gibberellic acid R. nodosus followed by M. globosus, A. fumigatus, C. echinulata, A. flavipes, C. herbarum, C. lunata, T. viridae, F. oxysporum f.sp. ciceri and sterile brown mycelium in inoculated and that of R. oryzae followed by A. flavus, A. fumigatus, A. sparsus, A. clavatus, A. terreus, C. aspermum, C. herbarum, M. echinata, T. viridae, H. fuscotra, D. hawaiensis and sterile black mycelium in uninoculated plants. On the other hand, with maleic hydrazide the frequency of most of the fungi decreased and the highest decrease in the frequency was that of A. alternata followed by S. rolfsii, R. nodosus, C. echinulata, M. globosus, A. flavipes, C. lunata, F. oxysporum f.sp. ciceri and sterile brown mycelium in inoculated and that of R. nodosus followed by A. terreus, H. fuscotra, R. oryzae, A. fumigatus, A. clavatus, C. herbarum, M. echinata, D. hawaiensis,

C. lunata, T. viridae and sterile black mycelium in uninoculated plants (Table 18). Sprays with growth promoting substances resulted in the increase in the frequency of most of the fungi.

Fertilizers:

Results presented in Tables 12 and 16 also show that as a result of spray of plants with fertilizers, the number of fungi in the rhizosphere increased with the increase in the number of sprays and the number of fungi in the rhizosphere was also more in those inoculated plants. In amonst the two varieties tested, the highest number of fungi was found in the rhizosphere of JG-62 both in inoculated and those uninoculated. When sprayed with urea, the number of fungi in the rhizosphere of JG-62 was 21, 28, 30 in inoculated as against 20, 25, 27 in uninoculated plants after respective sprays; with muriate of potash 19, 25, 29 in inoculated as against 18, 24, 26 in uninoculated plants. The number of fungi in the rhizosphere of those sprayed with water as control were 19, 26, 29 in inoculated as against 19, 24, 27 in uninoculated plants. With JG-74, the corresponding values were 23, 27, 29 in inoculated as against 20, 26, 27 in uninoculated plants when sprayed with urea and 22, 26, 28 in inoculated as against 19, 25, 27 in uninoculated plants with potash. The number of fungi in the rhizosphere of plants sprayed with water as

control was 21, 26, 28 in inoculated as against 19, 25, 27 in uninoculated plants.

Results with rhizoplane fungi also exhibited a similar trend (Table 14 and 18). In amongst the two cultivars tested number of fungi was more in rhizoplane of variety JG-62 both in inoculated and uninoculated plants. In rhizoplane of inoculated plants of JG-62, when sprayed with urea, the number of fungi was 17, 21, 24 in inoculated as against 15, 19, 20 in respective sprays in uninoculated plants and with muriate of potash 17, 21, 23 in inoculated as gainst 13, 19, 20 in uninoculated plants. The number of fungi was 15, 20, 23 in inoculated as against 15, 19, 20 in uninoculated plants when sprayed with water. With cv. JG-74 the corresponding values were 15, 18, 20 in inoculated as against 14, 18, 19 in uninoculated plants when sprayed with urea and 15, 17, 20 in inoculated as against 14, 18, 18 in uninoculated plants with Muriate of potash. The number of fungi was 15, 18, 20 in inoculated as against 14, 18, 19 in uninoculated plants when sprayed with water as control. However, the number of fungi was less in rhizoplane as compared to rhizosphere.

The population of fungi in the rhizosphere of both the varieties increased due to spray with urea however with muriate of potash, there was a decrease in the rhizosphere of JG-62 (Tables 10 and 11). However, the increase was more in inoculated

ones as compared to uninoculated ones.

Frequency of fungi in general showed an increase as a result of spray with urea. The frequency of sterile brown mycelium was highest in the rhizosphere of inoculated plants of JG-62 followed by Rhizopus oryzae, Monosporium olivacium, Botrytis cinerea, Spicaria silvatica and Fusarium oxysporum f.sp. ciceri that of R. oryzae, followed by Chaetomium flavum, S. silvatica, Memnoniella echinata, Fusarium moniliformae and sterile black mycelium in uninoculated; with muriate of potash, R. oryzae followed by Aspergillus fumigatus, A. flavus, A. niger, in inoculated plants as against Trichoderma viridae followed by sterile black mycelium, M. echinata, Aspergillus terreus, A. sparsus and R. oryzae in uninoculated plants (Table 12). In the rhizosphere of another variety JG-74, the highest increase in the frequency was that of T. viridae followed by sterile brown mycelium, A. flavus, A. niger, A. flavipes, M. echinata, Rhizopus nodosus, Phoma hibernica, Gliocladium roseum, Penicillium notatum, Alternata alternaria and F. oxysporum f.sp. ciceri when sprayed with urea in inoculated and that of Cephalosphorium aspermum followed by A. fumigatus. A niger, A. flavus, A. terreus A. clavatus, F. moniliformae, Rhizopus nodosus, T. viridae, M. echinata, Cladosporium herbarum, Alternaria humicola, G. roseum and P. notatum in uninoculated plants; with muriate of potash highest increase in the frequency was that of sterile

brown mycelium followed by M. echinata, T. viridae, A. clavatus, A. niger, A. flavus, A. fumigatus and R. nodosus in inoculated and that of sterile black mycleium followed by R. nodosus, T. viridae, A. clavatus, A. niger, A. fumigatus, A. terreus, P. hibernica and M. echinata in uninoculated plants (Table 16).

A similar trend was observed with rhizoplane fungi (Tables 14 and 18). As a result of spray with urea, highest increase in the frequency was that of Cunninghamella echinulata, followed by A. flavus, A. fumigatus, A. niger, sterile brown mycelium, C. flavum, D. hawaiensis, R. oryzae, S. rolfsii and F. oxysporum f.sp. ciceri in the rhizoplane of inoculated plants of JG-62; and A. fumigatus followed by A. flavus, A. niger, A. terreus, Humicola fuscotra, Curvularia lunata, C. herbarum M. echinata, T. viridae, R. oryzae, C. aspermum and sterile black mucelium in uninoculated plants, with muriate of potash highest increase in the frequency was that of A. flavus followed by A. niger, A. fumigatus, R. oryzae, C. echinulata, M. racemosus, M. alpina, C. herbarum and sterile brown mycelium in inoculated and A. terreus followed by A. flavus, A. niger, A. fumigatus, M. echinata, H. fuscotra, T. viridae and sterile black mucelium in ininoculated plants. With another variety JG-74 as a result of spray with urea highest increase in the frequency was that of A. clavatus followed by R. nodosus, T. viridae, sterile brown mycelium, A. flavus, A. fumigatus. C. echinulata,

M. alpina, D. hawaiensis, M. olivaceum, S. rolfsii and F. oxysporum f.sp. ciceri in inoculated and A. fumigatus followed by A. flavus, A. niger, A. terreus, A. clavatus, R. oryzae, C. aspermum, G. roseum, M. echinata, T. viridae, H. fuscotra and A. humicola in uninoculated plants, with muriate of potash highest increase in the frequency was that of A. clavatus followed by T. viridae, R. nodosus, A. fumigatus, A. flavus, A. niger, G. roseum and sterile brown mycelium in inoculated and R. nodosus followed by A. sparsus, A. terreus, A. clavatus, A. funigatus, T. viridae, M. echinata, D. hawaiensis and sterile black mycelium in uninoculated plants.

Pesticides:

Results presented in Tables 13 and 17 reveal that due to spray of plants with pesticides, the number of fungi in the rhizosphere increased with increase in the number of sprays but this increase was low than those sprayed with water. The number of fungi was also more in those inoculated with Fusarium oxysporum f.sp. ciceri. In amongst the two varieties tested the more number of fungi was reported from the rhizosphere of JG-62 both in inoculated and uninoculated when sprayed with bavistin the number of fungi in cv. JG-62 was 19, 24, 27 in inoculated as against 18, 24, 25 in uninoculated plants after respective sprays; with brassicol 15, 23, 27 in inoculated as against 15, 21, 23 in uninoculated plants; with vitavax 16,24,27

in inoculated as against 17, 22, 25 in uninoculated plants; with benlate, 14, 22, 24 in inoculated as against 14, 21, 23 in uninoculated plants; with captan 15, 23, 27 in inoculated as against 17, 22, 24 in uninoculated plants, with wettable sulphur 18, 24, 25 in inoculated as against 18, 23, 25 in uninoculated plants; and with streptomycine 20, 26, 29 in inoculated as against 19, 25, 27 in uninoculated plants. The number of fungi was 19, 26, 29 inoculated and 19, 24, 27 in uninoculated plants. when sprayed with water. With JG-74 the corresponding values were 22, 25, 26 in inoculated as against 19, 23, 24 in uninoculated plants when sprayed with bavistin, 22, 25, 25 as against 17, 21, 20 with brassicol, 22, 25, 24 as against 17, 23, 24 with vitatax, 20, 24, 24 as against 18, 21, 21 with benlate, 21, 24, 25 as against 18, 22, 23 with captan, 22. 25, 25 as against 17, 21, 22 with wettable sulphur and 22, 26, 26 as against 20, 23, 24 with streptomycine. The number of fungi in the rhizosphere of plants sprayed with water as control was 21, 25, 28 in inoculated as against 19, 25, 27 in uninoculated plants. An increase in the number of fungi in the rhizosphere was due to streptomycine sprays which was more than those spryaed with water out in the remaining there was decrease over control.

Almost identical results were observed with reaged to rhizoplane (Tables 18 and 19). Here also there has been more fungi in those inoculated with F. oxysporum f.sp. ciceri and

that too in JG-62. When sprayed with bavistin the number of fungi in rhizoplane of inoculated JG-62 plants was 16, 20, 21 as against 13, 19, 20 in respective sprays in uninoculated; with brassicol 15, 20, 23 in inoculated as against 12, 18, 19 in uninoculated; with vitavax 14, 20, 20 in inoculated as against 13, 19, 20 in uninoculated; with benlate 15, 20, 21 in inoculated as against 12, 18, 18 in uninoculated plants; with captan 13, 20, 21 in inoculated as against 12, 19, 21 in uninoculated plants; with wettable sulphur 17, 20, 22 in inoculated as against 13, 14, 19 in uninoculated plants; with streptomycin 16, 21, 23 in inoculated as against 13, 19, 19 in uninoculated plants. While the number of fungi in plants sprayed with water as control was 15, 20, 23 in inoculated as against 15, 19, 20 in uninoculated after respective sprays. With JG-74 the corresponding values were 14, 16, 18 in inoculated as against 14, 18, 18 in uninoculated when sprayed with bavistin; 15, 18, 19 as against 14, 18, 17 with brassicol 15, 18, 18 as against 14, 18, 18 with vitavax, 15, 15, 17 as against 14, 18, 18 with benlate, 14, 17, 18 as against 14, 18, 18 with captan, 14, 17, 18 as against 13, 17, 17 with wettable sulphur and 17, 19, 20 as against 16, 19, 19 with streptomycin . The number of fungi in the rhizoplane of plants sprayed with water as control was 15, 18, 20 in inoculated as against 14, 18, 19 in uninoculated plants. Here also the highest increase in the number of fungi was due to spray with streptomycine. However the number of fungi was less in rhizoplane as

compared to rhizosphere.

By and large the population of fungi in the rhizosphere of inoculated and uninoculated plants of both the varieties decreased due to spray with pesticides (Tables 10 and 11). The spray with streptomycin however brought about an increase. Highest decrease was observed when sprayed with bavistin and benlate.

Frequency of fungi in general showed a decrease as a result of spray with pesticides (Tables 13 and 17). As a result of spray with bavistin the highest reduction in the frequency in the rhizosphere of JG-62 inoculated plants was that of Fusarium oxysporum f.sp. ciceri followed by Mortierilla alpina, Aspergillus flavipes, Curvularia lunata, Alternaria alternata, Monosporium olivacium, Monilia humicola that of Cephalosporium aspermum followed by Aspergillus sparsus, Torulla allii, Memnoniella echinata, C. lunata, C. geniculata, Acrophialophora fusipora, Drechslera hawaiensis, Cladosporium herbarum, Alternaria alternata and Aspergillus terreus in uninoculated; with vitavax A. sparsus followed by Botrytis cinerea, Sclerotium rolfsii, Rhizoctonia solani, Syncephalastrum racemosum, Mucor racemosus, Aspergillus candidus, A. alternata and F. oxysporum f.sp. ciceri, S. silvatica, A. alternata, C. flavum and sterile brown mycelium in inoculated and that of A. terreus followed by T. allii, H. fuscoura,

C. geniculata, A. alternata, T. viridae, C. herbarum, A. niger, A. luchuensis, F. moniliformae, C. flavum, R. oryzae, M. humicola and sterile black mycelium in uninoculated plants, with brassicol, B. cineria followed by C. flavum, R. solani, C. lunata, S. silvatica, A. flavipes, A. sparsus, A. candidus, S. chrysospermum and A. fusipora in inoculated and that of A. terreus followed by A. flavipes, A. funiculosus, A.luchuensis, A. sparsus, A. alternata, F. moniliformae, C. aspermum, R. oryzae and sterile black mycelium in uninoculated plants, with benlate F. oxysporum f.sp. ciceri followed by sterile brown mycelium, M. alpina, A. alternata, M. racemosus, M. phaseolina, A. candidus, A. flavipes, A. sparsus, S. rolfsii, R. solani and B. cineria in inoculated and that of T. allii followed by C. aspermum, A. terreus, A. flavipes, H. fuscotra, C. lunata, C. geniculata, A. fusipora, M. humicola, C. flavum, F. moniliformae and sterile black mycelium in uninoculated plants; with captan A. candidus followed by C. flavum, M. phaseolina, S. rolfsii, F. oxysporum f.sp. ciceri, S. chrysospermum, A. alternata, C. lunata, A. fusipora, A. flavipes, S. racemosusm, M. olivaceum and B. cineria in inoculated and that of T. allii followed by B. pulluliferum, A. terreus, A. funiculosus, A. sparsus, A. flavipes, F. moniliformae, S. silvatica, T. viridae and sterile black mycelium in uninoculated plants; with wettable sulphur S. rolfsii followed by C. lunata, A. alternata, C. flavum,

M. olivaceum, B. cinerea, S. racemosum, M. phaseolina, A. sparsus, A. flavipes, S. chrysospermum, R. solani and F. oxysporum f.sp. ciceri in inoculated and that of A. sparsus followed by A. flavipes, H. fuscotra followed by C. lunata, F. moniliformae, T. viridae, D. hawaiensis, T. allii, A. terreus and A. alternata in uninoculated plants. On the other hand, with streptomycine the frequency of most of the fungi increased with highest increase that of sterile brown mycleium followed by M. racemosus, R. oryzae, M. humicola, A. fumigatus, A. sparsus, B. cinerea, R. solani and F. oxysporum f.sp. ciceri in inoculated and that of sterile black mycelium followed by B. piluliferum, C. aspermum, M. echinata, C. lunata, F. moniliformae, T. viridae, C. herbarum, M. humicola and R. oryzae in uninoculated plants. With another variety JG-74, as a result of spray with bavistin the highest reduction in the frequency was that of F. oxysporum f.sp. ciceri followed by S. rolfsii, A. flavipes, M. olivaceum, A. alternata, C. lunata, P. notatum, M. alpina and sterile brown mycelium in the rhizosphere of inoculated plants and that of R. nodosus followed by C. aspermum, P. hibernica, T. allii, C. lunata, F. moniliformae, H. fuscotra, D. hawaiensis, D. sativum, C. lunata, A. humicola, T. lignorum, T. viridae and sterile black mycelium in uninoculated plants, with vitavax, V. dlaucum, followed by A. alternata, S. rolfsii, C. lunata, A. candidus, M. alpina, C. flavum, M. humicola, P. notatum, G. roseum

and sterile brown mycelium in inoculated plants and that of D. sativum followed by T. lignorum, T. viridae, A. humicola, C. lunata, H. fuscotra, C. herbarum, T. allii, R. nodosus, C. aspermum, P. hibernica, A. clavatus and sterile brown mycelium in uninoculated plants; with brassicol that of C. lunata followed by V. glaucum, S. rolfsii, T. viridae, T. lignorum, P. notatum, M. olivaceum, G. racemosum and F. oxysporum f.sp. ciceri in inoculated and that of A. clavatus followed by A. humicola, C. lunata, R. nodosus, T. lignorum and M. echinata in uninoculated plants; with benlate that of F. oxysporum f.sp. ciceri followed by V. glaucum, A. candidus , A. clavatus, A. alternata, T. viridae, D. hawaiensis, P.notatum, G. racemosum, M. olivaceum, C. lunata and sterile brown mycelium in inoculated and that of R. nodosus, followed by P. hibernica, A. clavatus, P. notatum, G. roseum , T. allii, C. herbarum M. echinata, D. hawaiensis, A. humicola, F. moniliformae, T. lignorum and sterile black mycelium in uninoculated plants; with captan that of F. oxysporum f.sp. ciceri followed by T. lignorum, V. glaucum, A. candidus, A. clavatus, M. alpina and A. alternata inoculated and that of F. moniliformae follwed by A. humicola, C. lunata, D. hawaiensis, T. allii, P. notatum, A. clavatus, A. sparsus, C. aspermum and sterile black mycelium in uninoculated plants; with wettable sulphur C. echinulata followed by M. globosus, M. alpina, V. glaucum, C. lunata and F. oxysporum f.sp. ciceri in inoculated and that of R. nodosus

followed by P. hibernica, A. terreus, A. clavatus, P. notatum, M. echinata, D. hawaiensis, D. sativum, C. lunata, A. humicola, T. lignorum and sterile black mycelium in uninoculated plants. On the other hand, with streptomycine the frequency of fungi increased with highest increase that of A. clavatus followed by A. flavus, A. fumigatus, A. niger, A. flavipes, A. candidus, A. alternata, P. notatum, C. flavum, R. nodosus, M. echinata, T. viridae and sterile brown mycelium in inoculated and that of P. hibernica followed by A. fumigatus, A. flavus, A. niger, A. sparsus, A. flavipes, C. herbarum, M. echinata, H. fuscotra, T. viridae, T. lignorum, C. aspermum, P. notatum, G. racemosum and sterile black mycelium in uninoculated plants.

A similar trend was observed the changes in frequency of rhizoplane fungi (Tables 15 and 19). As a result of spray with bavistin highest decrease in the frequency was that of F. oxysporum f.sp.ciceri followed by S. rolfsii, A. alternata, B. cinerea, A. flavipes, M. phaseolina, C. lunata, D.hawaiensis, A. sparsus, A. candidus, M. albina and sterile brown mycelium in inoculated plants and that of A. fusipora followed by M. echinata, C. lunata, A. terreus, A. flavus, A. sparsus, A. flavipes, H. fuscotra, T. viridae and sterile black mycelium in uninoculated plants; with vitavax B. cinerea followed by M. albina, A. alternata, C. lunata, M. phaseolina, C. flavum, A. flavus, A. sparsus and sterile brown mycelium in inoculated and that of C. spermum followed by A. terreus, A. luchuensis,

A. humicola, D. hawaiensis, A. flavus, A. sparsus, A. flavipes, A. niger, R. oryzae, H. fuscotra, T. viridae, C. herbarum, M. echinata and sterile black mycelium in uninoculated plants; with brassicol A. flavipes followed by S. rolfsii, A. fusipora, A. alternata, C. lunata, R. solani, A. sparsus, A. candidus, B. cinerea and sterile brown mycelium in inoculated and that of H. fuscotra followed by C. lunata, C. herbarum, M. echinata A. terreus, A. niger, A. flavipes, A. sparsus, A. luchuensis, D. hawaiensis, T. viridae and sterile black mycelium in uninoculated plants, with benlate F. oxysporum f.sp. ciceri followed by M. olivaceum, A. fusipora, C. lunata, R. oryzae, A. candidus, A. flavipes, M. racemosus, M. alpina, C. flavum M. phaseolina, B. cinerea, A. alternata and sterile brown mycelium in inoculated and that of M. echinata followed by T. viridae, A. niger, A. terreus, A. flavus, D. hawaiensis, C. lunata, C. aspermum, R. oryzae, C. herbarum, C. flavum and sterile black mycelium in uninoculated plants; with captan B. cinerea followed by C. flavum, M. phaseolina, A. alternata, M. alpina, C. lunata , M. olivaceum, M. phaseolina, R. solani, S. rolfsii, A. candidus, A. flavipes, A. sparsus, F. oxysporum f.sp.ciceri and sterile brown mycelium in inoculated and that of A. flavipes followed by A. terreus, A. sparsus, C. herbarum, D. hawaiensis, C. lunata, S. rolfsii, R. oryzae, C. aspermum, A. niger, T. viridae, H. fuscotra and sterile black mycelium in uninoculated plants, on the other hand with streptomycin

the frequency of most of the fungi increased in both inoculated and uninoculated plants. The frequency of M. phaseolina increased highest followed by A. candidus, A. flavipes, A. sparsus, A. fumigatus, A. flavus, R. oryzae, M. racemosus, M. alpina, C. lunata, D. hawaiensis, S. rolfsii, R. solani B. cinerea, F. oxysporum f.sp. ciceri in inoculated and that of A. fumigatus followed by C. lunata, C. herbarum, T. viridae, D. hawaiensis, R. oryzae, C. aspermum, A. niger, A. flavipes, M. echinata, Fusarium oxysporum and sterile black mycelium in uninoculated plants. With another variety JG-74, as a result of spray with bavistin highest reduction in the frequency was that of A. alternata in the rhizoplane of inoculated plants followed by S. rolfsii, M. olivaceum, G. roseum, F. oxysporum f.sp. ciceri, M. alpina and sterile brown mycelium and that of R. oryzae followed by A. terreus, M. echinata, T. viridae, C. aspermum, A. flavus, A. clavatus, A. sparsus, H. fuscotra, D. hawaiensis, A. humicola, C. lunata, C. herbarum and sterile black mycelium in uninoculated plants; with vitavax A. alternata followed by F. oxysporum f.sp. ciceri, M. alpina, G. roseum, S. rolfsii, C. lunata and sterile brown mycelium in inoculated and that of A. humicola followed by C. herbarum, R. nodosus, D. hawaiensis, C. lunata, H. fuscotra, T. viridae, C. aspermum, A. flavus, A. terreus, A. sparsus and sterile black mycelium in uninoculated plants; with brassicol M. alpina followed by A. alternata, F. oxysporum f.sp. ciceri, A. flavipes,

G. roseum , T. viridae and sterile brown mycelium in inoculated and that of R. nodosus followed by D. hawaiensis, T. viridae M. echinata, C. aspermum, A. terreus, A. flavus, A. clavatus, A. sparsus, R. oryzae, C. lunata and A. humicola in uninoculated plants; with benlate F. oxysporum f.sp. ciceri followed by C. lunata, M. olivaceum, S. rolfsii, A. clavatus, A. flavipes, C. echinulata, M. globosus, G. roseum , T. viridae and sterile brown mycelium in inoculated and that of A. clavatus followed by H. fuscotra, M. echinata, R. nodosus, C. herbarum, G. roseum , T. viridae, A. terreus, A. flavus, R. oryzae, A. humicola, D. hawaiensis, C. lunata and sterile black mycelium in uninoculated plants; with captan M. alpina followed by F. oxysporum f.sp. ciceri, C. lunata, C. echinulata, A. alternata, A. clavatus in inoculated and that of R. nodosus followed by A. humicola, A. clavatus, C. herbarum, A. niger, A. terreus A. sparsus, R. oryzae, H. fuscotra, T. viridae, M. echinata, C. aspermum, and D. hawaiensis in uninoculated plants; with wettable sulpher R. nodosus followed by M. alpina, M. olivaceum, F. oxysporum f.sp. ciceri, C. echinulata, M. globosus, A. flavipes, A. alternata and C. lunata in inoculated and that of A. clavatus followed by R. nodosus, A. terreus, A. sparsus, A. humicola, C. lunata, M. echinata, R. oryzae H. fuscotra, A. niger, A. flavus, D. hawaiensis, G. roseum and sterile black mycelium in uninoculated plants. On the other hand with streptomycin the frequency of fungi increased

with highest increase that of R. nodosus followed by A. clavatus, A. alternata, C. echinulata, A. flavipes, M. olivaceum, T. viridae, M. echinata and sterile brown mycelium in inoculated and that of A. fumigatus followed by A. niger, A. flavus, A. clavatus, A. terreus, A. humicola, R. nodosus, R. oryzae, C. aspermum, G. roseum , M. echinata, T. viridae, D. hawaiensis, C. lunat and sterile black mycelium in uninoculated plants.

It is interesting that as a result of spray with growth promoting substances, there has been higher increase in the frequency of saprophytic fungi in the rhizosphere of both the varieties except with gibberellic acid where highest increase was that of Fusarium oxysporum f.sp. ciceri a pathogenic fungi in inoculated JG-62 plants. It might be one of the factors for high incidence of wilt desease due to spray with gibberellic acid. This was not true however with the rhizosphere of JG-74 which is relatively less susceptibleto wilt. There were higher number of saprophytic fungi in the treatment with indole butyric acid followed by gibberellic acid, thio indole butyric acid and indole acetic acid with the rhizosphere of JG-62; but with the rhizosphere of JG-74 it was gibberellic acid, thio indole butyric acid indole acedic acid and indole butyric acid. On the other hand with maleic hydrazide, there was a reduction in the frequency of large number of saprophytic, parasitic and also some antibiotic producing fungi in both the varieties.

With rhizoplane fungi the frequency of fungi showing increase particularly the saprophytic fungi in the rhizosphere of JG-62 was more with indole butyric acid followed by gibberellic acid, indole acetic acid and thio indole butyric acid. It appears that indole butyric acid was more favourable for increase in saprophytic fungi however with JG-74 gibberellic acid was more effective followed by thio indole butyric acid. The response of indole butyric acid and indole acedic acid was almost identical. On the other hand with maleic hydrazide, generally the frequency of fungi showed reduction and this reduction was more in the saprophytic fungi in both the cultivars.

With fertilizers urea was more effective than muriate of potash in increasing the activity of saprophytic fungi but with muriate of potash highest increase in the frequency was that of T. viridae in the rhizosphere of JG-74 inoculated plants which could be exploited for control. Similarly with cv. JG-74 T. viridae was greatly increased with muriate of potash and urea in inoculated and uread followed by muriate of potash in uninoculated plants.

In the rhizoplane also urea increased the frequency of large number of saprophytic fungi in both the varieties in inoculated and muriate of potash in uninoculated of cv.JG-62 but in cv.JG-74 effect of both the fertilizers was identical.

As a result of spray with fungicides there was a reduction in the frequency of large number of saprophytic and parasitic fungi. In some cases even the frequency of antibiotic producing fungi decreased. The spray with streptomycin however brought about an increase in frequency of all the fungi.

FIG. 3. Population of fungi in the rhizosphere of uninoculated and inoculated plants of chickpea cultivar JG-62 (with Fusarium oxysporum f.sp. ciceri) treated with different foliar sprays.

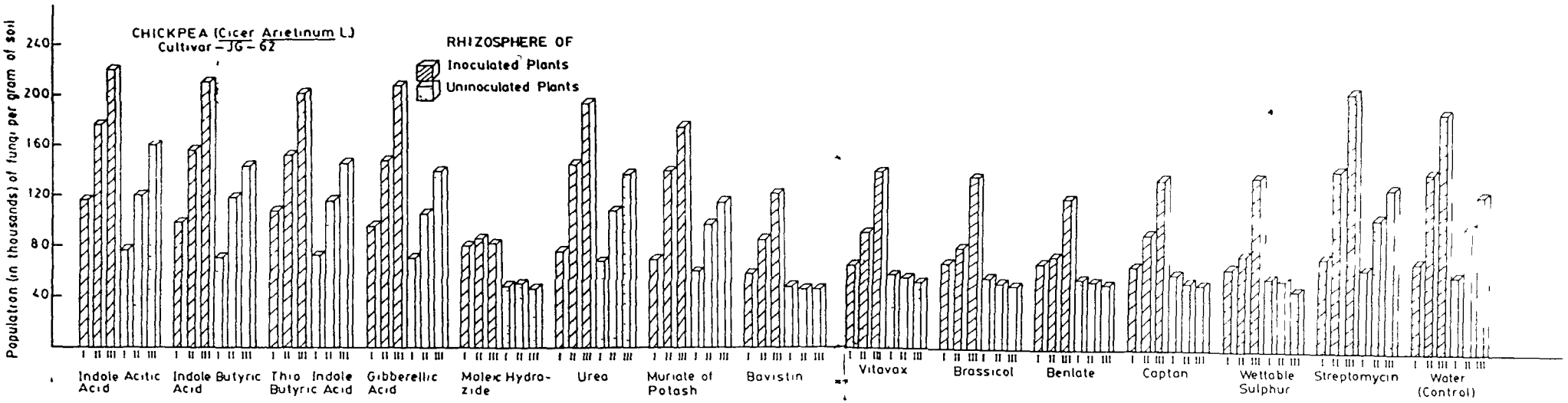
CHICKPEA (Cicer Arietinum L.)
Cultivar – JG – 62
RHIZOSPHERE OF
Inoculated Plants
Uninoculated Plants
Population (in thousands) of fungi per gram of soil
240
200
160
120
80
40
Indole Acitic Acid
Indole Butyric Acid
Thio Indole Butyric Acid
Gibberellic Acid
Molex Hydrazide
Urea
Muriate of Potash
Bavistin
Vitavax
Brassicol
Benlate
Captan
Wettable Sulphur
Streptomycin
Water (Control)
FOLIAR SPRAY

Fig 3

FIG. 4. Population of fungi in the rhizosphere of uninoculated and inoculated plants of chickpea cultivar JG-74 (with *Fusarium oxysporum* f.sp. *ciceri*) treated with different foliar sprays.

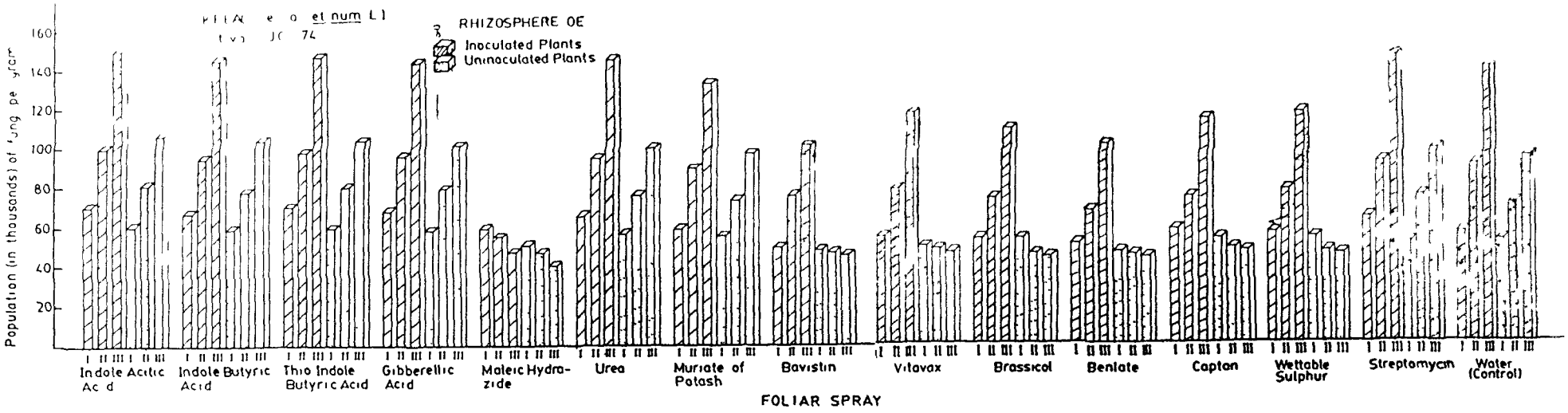
RHIZOSPHERE OE
Inoculated Plants
Uninoculated Plants
Population (in thousands) of fung pe gram
160
140
120
100
80
60
40
20
Indole Acitic Acid
Indole Butyric Acid
Thio Indole Butyric Acid
Gibberellic Acid
Maleic Hydrazide
Urea
Muriate of Potash
Bavistin
Vitavax
Brassicol
Benlate
Captan
Wettable Sulphur
Streptomycin
Water (Control)
FOLIAR SPRAY

Fig 4

TABLE - 10: Effect of foliar spray of different chemicals on population of fungi (per gram of soil) in the non-rhizosphere and rhizosphere cultivar JG-62 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri

TREATMENT	JG-62											
	INOCULATED PLANTS						UNINOCULATED PLANTS					
	I Spray	R:S	II Spray	R:S	III Spray	R:S	I Spray	R:S	II Spray	R:S	III Spray	R:S
Non-rhizosphere	15.5		16.5		17.0		15.5		16.5		17.0	
Control	72.5	4.68	142.5	8.64	190.0	11.17	61.0	3.94	100.0	6.06	125.0	7.35
Indole Acitic Acid	115.0	7.42	176.0	10.67	220.0	12.94	75.0	4.84	120.0	7.27	160.0	9.41
Indole Butyric Acid	98.0	6.32	155.0	9.39	210.0	12.35	70.0	4.52	118.0	7.15	143.0	8.41
Thio-indole Butyric Acid	108.0	6.67	152.0	9.21	202.0	11.88	72.0	4.65	115.0	6.97	145.0	8.53
Gibberellic Acid	95.0	6.13	148.0	8.97	208.0	12.24	70.0	4.52	105.0	6.36	140.0	8.23
Maleic Hydrazide	80.0	5.16	85.5	5.18	82.5	4.85	48.0	3.10	50.0	3.13	45.0	2.64
Urea	76.0	4.90	145.0	8.79	193.0	11.35	68.0	4.39	108.0	6.56	137.0	8.06
Muriate of Potash	70.0	4.52	140.0	6.06	125.0	7.39	60.0	3.23	98.0	4.73	115.0	6.76
Bauistin	58.0	3.74	85.0	5.15	122.0	7.18	48.5	3.13	47.0	2.85	46.0	2.70
Vitavax	66.5	4.29	92.0	4.36	140.0	8.24	58.0	3.74	56.0	3.39	53.0	3.11
Brassicol	68.5	4.42	80.5	4.27	137.0	8.06	55.5	3.58	52.0	3.15	49.5	2.91
Benlate	68.0	4.39	74.0	4.48	120.0	7.06	56.0	3.61	53.5	3.24	51.0	3.00
Captan	67.0	4.32	93.5	5.67	135.0	7.94	59.5	3.84	54.5	3.30	51.0	3.00
Wettable Sulphur	65.0	4.19	75.0	4.55	138.0	8.12	57.0	3.68	56.5	3.42	48.5	4.19
Streptomycine	74.0	4.77	144.5	8.72	205.5	12.05	65.5	4.19	106.0	6.42	130.0	7.64
L.S.D. at 5%	1.4467968		1.5512628		1.647438		0.8593665		0.8496069		0.8517855	
L.S.D. at 1%	1.9484286		2.089115		2.2186959		1.1573251		1.1441817		1.1471157	

In thousands?

Needs analysis

TABLE - 11: Effect of foliar spray of different chemicals on population of fungi (per gram of soil) in the non-rhizosphere and rhizosphere of chickpea cv JG-74 uninoculated and inoculated with *Fusarium oxysporum* f.sp. *ciceri*

TREATMENT	JG-74											
	INOCULATED PLANTS						UNINOCULATED PLANTS					
	I Spray	R:S	II Spray	R:S	III Spray	R:S	I Spray	R:S	II Spray	R:S	III Spray	R:S
Non-rhizosphere	15.5		16.5		17.0		15.5		16.5		17.0	
Control	56.0	3.61	90.0	5.45	140.0	8.24	52.0	3.35	70.0	4.24	95.0	5.59
Indole Acitic Acid	71.0	4.73	100.0	6.06	150.0	8.82	60.0	3.87	81.0	4.91	107.0	6.29
Indole Butyric Acid	66.0	4.26	95.0	5.76	145.0	8.53	58.5	3.77	77.5	4.70	103.5	6.09
Thio-indole Butyric Acid	70.0	4.52	98.0	5.94	147.0	8.64	59.0	3.81	80.0	4.85	104.0	6.11
Gibberellic Acid	68.5	4.41	96.0	5.82	144.0	8.47	58.0	3.74	79.0	4.79	102.0	6.00
Maleic Hydrazide	59.0	3.81	55.0	3.34	51.5	3.02	50.0	3.23	46.0	2.70	40.0	2.35
Urea	65.0	4.20	94.5	5.73	145.0	8.53	56.0	3.61	76.0	4.61	100.0	5.88
Muriate of Potash	58.0	3.74	90.0	4.85	134.5	7.91	55.0	3.55	74.0	4.48	98.0	5.76
Bavistin	49.0	3.16	76.0	4.61	102.0	6.00	47.0	3.03	46.5	2.82	45.0	2.65
Vitavax	55.0	3.55	78.5	4.76	118.0	6.94	49.5	3.19	47.5	2.88	46.5	2.74
Brassicol	54.0	3.48	75.5	4.56	110.0	6.47	53.5	3.42	46.0	2.78	44.0	2.59
Benlate	51.5	3.32	68.0	4.12	102.0	6.00	46.0	2.97	45.5	2.76	43.5	2.56
Captan	58.0	3.74	76.0	4.61	115.0	6.76	53.0	3.42	48.5	2.93	47.0	2.76
Wettable Sulphur	56.5	3.66	78.0	4.73	117.0	6.88	54.0	3.48	46.0	2.79	45.0	2.65
Streptomycine	64.0	4.13	92.0	5.58	146.0	8.58	55.5	3.58	74.5	4.52	99.0	5.82
L.S.D. at 5%	1.8375476		2.0939766		1.934818		1.4560538		1.5805541		2.5850337	
L.S.D. at 1%	2.4746601		2.8199979		2.605656		1.9608952		2.1285621		3.5157482	

needs analysis

Fungi isolated	CONTROL						INDOLE AGITIC ACID						INDOLE BUTYRIC ACID						TRIO INDOLE BUTYRIC ACID						GIBBERELLEX ACID						MALEIC HYDRAZIDE						UREA						MURIATE OF POTASH					
	IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP		
	I*	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	25	20	20	20	30	30	30	30	35	35	40	45	30	30	30	30	35	40	35	40	45	20	35	45	25	20	20	25	35	40	20	15	15	15	20	20	35	30	40	35	45	50	35	30	30	25	35	40
Cunninghamella echinulata	20	25	30	-	-	-	30	35	40	-	-	-	25	30	35	-	-	-	15	20	25	-	-	-	25	30	35	-	-	-	10	20	20	-	-	-	30	35	35	-	-	-	20	30	40	-	-	-
Mucor racemosus	10	15	15	-	-	-	20	25	25	-	-	-	15	20	25	-	-	-	10	20	30	-	-	-	15	20	30	-	-	-	10	5	5	-	-	-	10	20	30	-	-	-	15	25	35	-	-	-
Mortierilla alpina	10	15	20	-	-	-	15	20	30	-	-	-	15	25	35	-	-	-	15	25	30	-	-	-	15	20	25	-	-	-	15	15	20	-	-	-	30	40	50	-	-	-	30	40	45	-	-	-
Monilia humicola	20	30	35	20	25	30	25	35	45	30	35	45	20	30	40	25	30	35	25	35	40	25	30	35	25	35	40	20	30	35	15	20	25	20	20	25	20	30	40	30	35	40	20	35	40	20	30	35
Cephalosporium aspermum	15	10	10	10	15	20	15	15	15	15	25	40	10	5	5	15	15	25	15	10	5	25	30	35	-	10	10	15	25	30	10	5	-	-	10	10	15	15	20	15	15	25	15	15	15	15	25	25
Syncephalastrum racemosum	20	25	35	-	-	-	25	35	40	-	-	-	25	35	45	-	-	-	30	40	45	-	-	-	30	40	50	-	-	-	10	15	25	-	-	-	25	35	40	-	-	-	20	25	20	-	-	-
Chaetomium flavum	5	15	20	15	25	30	10	20	25	15	30	45	25	30	25	35	45	50	-	15	25	20	35	50	-	15	25	15	30	25	-	5	10	10	15	20	10	15	30	25	35	45	10	15	15	-	-	-
Macrophomina phaseolina	-	20	25	-	-	-	-	35	40	-	-	-	-	25	35	-	-	-	-	25	30	-	-	-	15	25	40	-	-	-	-	-	-	-	-	-	10	25	35	-	-	-	-	25	15	-	-	-
Aspergillus fumigatus	40	35	35	30	25	25	60	50	40	45	35	30	40	35	35	50	45	40	35	30	30	40	40	45	50	50	55	55	50	45	25	15	10	55	45	45	30	30	35	50	55	50	40	35	30
A. flavus	30	25	25	25	35	45	45	40	35	50	50	35	40	35	35	30	40	30	40	30	30	35	45	50	30	25	20	30	25	20	20	25	25	40	40	40	35	50	50	40	50	55	30	40	50			
A. niger	20	20	35	30	35	45	50	40	40	45	60	70	25	25	40	30	40	45	25	30	40	30	40	50	30	35	40	35	40	45	15	20	10	35	40	50	30	35	40	40	45	50	35	45	55	45	45	50
A. funiculosus	-	-	-	25	20	15	-	-	-	30	30	20	-	-	-	20	15	15	-	-	-	20	20	15	-	-	-	25	25	20	-	-	-	25	25	20	-	-	-	30	25	15	-	-	-	20	25	25
A. terreus	-	-	-	20	25	25	-	-	-	25	30	30	-	-	-	25	35	30	-	-	-	25	30	30	-	-	-	25	35	40	-	-	-	20	20	20	-	-	-	20	25	35	-	-	-	25	30	40
A. fuchuensis	-	-	-	10	15	25	-	-	-	25	30	40	-	-	-	10	15	25	-	-	-	10	20	30	-	-	-	10	20	30	-	-	-	10	10	10	-	-	-	15	25	35	-	-	-	15	20	30
A. candidus	-	20	25	-	-	-	-	20	30	-	-	-	-	20	30	-	-	-	-	20	30	-	-	-	-	20	30	-	-	-	-	10	10	-	-	-	-	25	35	-	-	-	-	30	35	-	-	-
A. sparsus	15	15	20	20	25	25	15	25	25	20	30	35	15	20	25	15	25	35	10	10	20	25	35	40	15	20	30	20	25	30	15	10	10	20	25	25	10	20	30	15	20	35	20	20	15	20	30	35
A. flavipes	25	30	35	15	10	20	30	35	50	20	25	30	33	35	40	30	25	25	25	35	40	20	20	35	30	35	50	25	25	30	15	20	20	5	5	10	30	35	40	15	15	30	25	30	35	20	15	15
Monosporium olivaceum	10	15	25	-	-	-	20	25	40	-	-	-	20	25	30	-	-	-	20	25	40	-	-	-	20	25	35	-	-	-	10	10	15	-	-	-	15	30	40	-	-	-	15	20	20	-	-	-
Botrytis cinerea	15	20	25	-	-	-	15	25	30	-	-	-	15	20	20	-	-	-	15	25	30	-	-	-	15	25	30	-	-	-	5	10	15	-	-	-	20	30	40	-	-	-	15	15	10	-	-	-
Torulla allii	-	-	-	20	20	25	-	-	-	20	25	30	-	-	-	20	30	35	-	-	-	20	20	25	-	-	-	25	25	30	-	-	-	15	15	20	-	-	-	20	25	30	-	-	-	15	20	30
Sepdonium chrysospermum	-	-	10	-	-	-	-	-	15	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	10	-	-	-
Botryotrichum pulluliferum	-	-	-	15	-	-	-	-	-	20	10	-	-	-	-	10	-	-	-	-	-	25	15	10	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spicaria silvatica	-	-	20	-	-	10	-	-	25	-	-	40	-	-	20	-	-	20	-	-	30	-	-	10	-	-	25	-	-	20	-	-	-	-	-	-	-	-	25	20	30	-	-	15	-	-	-	25	20	15
Cladosporium herbarum	20	25	30	20	25	25	30	40	40	25	30	40	25	30	35	25	30	30	20	25	25	20	30	35	30	35	50	30	30	45	15	10	10	20	20	15	20	30	40	20	30	30	25	30	40	20	30	35
Trichosporium fuscum	-	-	25	-	-	15	-	-	30	-	-	20	-	-	30	-	-	15	-	10	20	-	-	25	-	-	30	-	-	20	-	-	20	-	-	15	-	20	30	-	-	20	-	-	20	-	-	10
Humicola fuscotra	-	-	-	-	20	20	-	-	-	-	15	20	-	-	-	-	20	25	-	-	-	-	25	35	-	-	-	-	25	40	-	-	-	-	20	15	-	-	-	25	30	-	-	-	25	35	45
Memmoniella echinata	-	-	-	15	20	25	-	-	-	20	25	35	-	-	-	15	20	30	-	-	-	25	30	35	-	-	-	25	35	40	-	-	-	15	10	15	-	-	-	20	30	40	-	-	-	20	30	40
Drechslera hawaiensis	-	35	25	-	25	20	-	35	30	-	40	40	20	30	30	10	20	30	-	35	25	-	30	25	-	40	30	-	35	35	-	20	15	-	20	15	-	35	35	15	35	40	-	25	20	-	20	15
Curvularia lunata	-	30	35	-	25	25	25	35	40	-	35	35	15	40	40	25	35	40	25	40	50	-	30	30	40	50	60	25	30	40	15	25	30	-	20	25	25	35	40	-	25	35	-	25	25	-	20	15
C. geniculata	-	-	-	-	-	20	-	-	-	-	-	25	-	-	-	-	-	35	-	-	-	-	20	40	-	-	-	-	-	15	-	-	-	-	-	10	-	-	-	-	-	30	-	-	-	-	-	25
Alternaria alternata	20	25	35	20	25	30	20	40	50	25	30	35	25	35	45	25	30	35	25	30	50	20	30	35	25	25	35	15	20	20	10	15	10	20	20	15	25	35	45	25	30	35	25	25	30	20	20	20
Fusarium moniliformae	-	-	-	-	15	20	-	-	-	-	30	35	-	-	-	-	25	35	-	-	-	-	20	25	-	-	-	-	20	30	-	-	-	-	15	20	-	-	-	-	25	35	-	-	-	-	15	15
F. oxysporum	-	-	-	-	15	25	-	-	-	-	20	35	-	-	-	-	20	30	-	-	-	-	20	30	-	-	-	-	25	35	-	-	-	-	25	35	-	-	-	-	15	20	-	-	-	-	20	15
F. oxysporum f.sp. ciceri	65	70	75	-	-	-	70	75	80	-	-	-	70	70	80	-	-	-	65	70	80	-	-	-	70	75	90	-	-	-	55	50	35	-	-	-	65	75	85	-	-	-	60	50	65	-	-	-
Acrophialophora fusispora	-	20	25	-	10	15	-	20	30	-	15	20	-	20	25	-	15	20	-	20	25	-	15	20	-	15	10	-	15	15	-	-	5	-	25	25	-	15	15	-	25	20	-	10	10			
Trichoderma viridae	-	-	-	15	20	30	-	-	-	20	30	40	-	-	-	20	25	35	-	-	-	20	25	35	-	-	-	20	30	35	-	-	-	10	15	25	-	-	15	20	30	40	-	-	-	20	25	45
Sclerotium rolfsii	-	10	10	-	-	-	-	15	25	-	-	-	-	20	30	-	-	-	-	15	25	-	-	-	-	20	30	-	-	10	-	-	10	-	-	-	-	15	25	-	-	-	-	5	5	-	-	-
Rhizoctonia solani	-	15	20	-	-	-	-	20	25	-	-	-	-	10	15	-	-	-	-	20	35	-	-	-	-	20	25	-	-	-	-	15	10	-	-	-	-	15	15	-	-	-	-	10	-	-	-	-
Sterile brown mycelium	15	20	25	-	-	-	20	25	35	-	-	-	15	25	30	-	-	-	20	30	40	-	-	-	20	30	40	-	-	-	20	20	15	-	-	-	20	30	40	-	-	-	15	25	35	-	-	-
Sterile black mycelium	-	-	-	20	25	30	-	-	-	20	25	35	-	-	-	20	30	40	-	-	-	20	20	25	-	-	-	20	20	30	-	-	-	25	20	20	-	-	-	30	40	50	-	-	-	20	30	40

*Number of spray

IP = Inoculated plants. UF = Uninoculated plants.

Fungi isolated	CONTROL						BAVISTIN						VITAVAX						BRASSICOL					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	25	20	20	20	30	30	20	20	25	15	20	20	30	25	20	15	15	10	25	25	30	20	10	5
Cunninghamella echinulata	20	25	30	-	-	-	25	30	30	-	-	-	25	30	35	-	-	-	15	25	35	-	-	-
Mucor racemosus	10	15	15	-	-	-	15	15	10	-	-	-	[illegible]	[illegible]	5	-	-	-	15	15	15	-	-	-
Mortierilla alpina	10	15	20	-	-	-	10	10	5	-	-	-	10	10	15	10	10	-	10	10	10	-	-	-
Monilia humicola	20	30	35	20	25	30	15	20	15	20	20	25	20	20	25	20	15	10	15	15	20	20	25	25
Cephalosporium aspermum	15	10	10	10	15	20	10	5	5	10	5	-	-	-	-	10	10	5	-	-	-	10	15	10
Syncephalastrum aspermum	20	25	35	-	-	-	20	20	20	-	-	-	[illegible]	[illegible]	10	-	-	-	20	25	25	-	-	-
Chaetomium flavum	5	15	20	15	25	30	5	10	10	10	15	20	-	10	10	-	-	10	-	-	10	-	10	20
Macrophomina phaseolina	-	20	25	-	-	-	-	15	10	-	-	-	-	10	15	-	-	-	-	15	15	-	10	20
Aspergillus fumigatus	40	35	35	30	25	25	40	45	50	45	40	30	40	40	45	35	30	25	40	45	45	30	30	30
A. flavus	30	25	25	25	35	45	25	30	40	35	30	30	35	35	30	20	30	35	35	30	25	25	30	35
A. niger	20	20	35	30	35	45	25	35	45	30	25	25	25	30	35	25	20	20	20	30	40	30	30	30
A. funiculosus	-	-	-	25	20	15	-	-	-	20	15	10	-	-	-	20	15	-	-	-	-	15	10	-
A. terreus	-	-	-	20	25	25	-	-	-	10	10	10	-	-	-	10	10	5	-	-	-	10	5	5
A. luchuensis	-	-	-	10	15	25	-	-	-	10	10	15	-	-	-	15	15	10	-	-	-	-	5	10
A. candidus	-	20	25	-	-	-	-	15	10	-	-	-	-	[illegible]	20	-	-	-	-	15	10	-	-	-
A. sparsus	15	15	20	20	25	25	-	10	10	10	5	10	5	5	-	10	10	10	-	10	10	10	10	10
A. flavipes	25	30	35	15	10	20	20	20	15	15	10	15	20	20	15	10	15	25	15	10	10	-	-	10
Monosporium olivaceum	10	15	25	-	-	-	10	10	15	-	-	-	[illegible]	20	25	-	-	-	10	5	15	-	-	-
Botrytis cinerea	15	20	25	-	-	-	10	-	-	-	-	-	-	[illegible]	[illegible]	-	-	-	-	5	5	-	-	-
Torulla allii	-	-	-	20	20	25	-	-	-	15	10	10	-	-	-	10	15	10	-	-	-	-	10	-
Sepdonium chrysospermum	-	-	10	-	-	-	-	-	-	-	-	-	-	-	[illegible]	-	-	-	-	-	5	-	-	-
Botryotrichum pulluliferum	-	-	-	15	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Spicaria silvatica	-	-	20	-	-	10	-	-	20	-	-	-	-	[illegible]	10	-	-	-	-	-	5	-	-	-
Cladosporium herbarum	20	25	30	20	25	25	25	25	30	15	10	15	20	[illegible]	[illegible]	[illegible]	15	10	15	[illegible]	[illegible]	15	15	15
Trichosporium fuscum	-	-	25	-	-	15	-	-	15	-	-	10	-	-	[illegible]	-	-	[illegible]	-	-	20	-	-	5
Humicola fuscotra	-	-	-	-	20	20	-	-	-	-	10	15	-	-	-	-	[illegible]	[illegible]	-	-	-	-	10	15
Memnoniella echinata	-	-	-	15	20	25	-	-	-	10	10	10	-	-	-	15	15	15	-	-	-	10	15	20
Drechslera hawaiensis	-	35	25	-	25	20	-	[illegible]	10	-	10	10	-	[illegible]	[illegible]	-	[illegible]	15	-	[illegible]	30	-	-	-
Curvularia lunata	-	30	35	-	25	25	20	20	20	-	15	10	-	[illegible]	35	-	15	15	-	15	10	-	10	10
C. geniculata	-	-	-	-	-	20	-	-	-	-	-	10	-	-	-	-	-	[illegible]	-	-	-	-	-	15
Alternaria alternata	20	25	35	20	25	30	15	15	15	-	10	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20	20	15
Fusarium moniliformae	-	-	-	-	15	20	-	-	-	-	15	15	-	-	-	-	[illegible]	10	-	-	-	-	5	5
F. oxysporum	-	-	-	-	15	25	-	-	-	-	15	20	-	-	-	-	-	15	-	-	-	-	-	15
F. oxysporum f. sp. ciceri	65	70	75	-	-	-	50	25	10	-	-	-	[illegible]	[illegible]	35	-	-	-	50	20	15	-	-	-
Acrophialophora fusispora	-	20	25	-	10	15	-	15	15	-	[illegible]	5	-	[illegible]	15	-	10	15	-	10	15	-	10	10
Trichoderma viridae	-	-	-	15	20	30	-	-	-	15	15	15	-	-	-	15	10	10	-	-	-	10	10	15
Sclerotium rolfsii	-	10	10	-	-	-	-	5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhizoctonia solani	-	15	20	-	-	-	-	-	5	-	-	-	-	-	5	-	-	-	-	5	5	-	-	-
Sterile brown mycelium	15	20	25	-	-	-	10	15	20	-	-	-	5	[illegible]	10	-	-	-	10	15	20	-	-	-
Sterile black mycelium	-	-	-	20	25	30	-	-	-	15	20	25	-	-	-	10	10	10	-	-	-	20	20	20

Fungi isolated	BENLATE						CAPTAN						WETTABLE SULPHURE						STEPTOMYCIN					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	20	20	15	20	15	10	30	30	30	20	15	15	[illegible]	20	15	20	25	20	25	25	30	25	35	50
Cunninghamella echinulata	-	-	-	10	15	20	-	-	-	-	-	-	20	20	25	-	-	-	25	30	40	-	-	-
Mucor racemosus	-	-	-	-	-	-	-	15	15	-	-	-	15	20	25	-	-	-	15	25	30	-	-	-
Mortierilla alpina	-	10	10	-	-	-	-	15	25	-	-	-	10	15	15	-	-	-	15	20	25	-	-	-
Monilia humicola	10	20	20	-	20	20	15	20	25	15	20	20	[illegible]	25	20	15	20	20	25	35	45	25	30	40
Cephalosporium aspermum	-	-	-	10	5	-	-	-	-	-	-	-	-	-	-	10	5	5	20	10	5	15	25	30
Syncephalastrum aspermum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	10	-	-	-	-	-	-
Chaetomium flavum	15	20	30	-	-	-	15	15	15	-	-	-	[illegible]	10	10	-	-	-	25	40	40	-	-	-
Macrophomina phaseolina	-	-	-	10	10	15	15	20	[illegible]	5	5	10	-	10	10	15	15	15	10	10	20	20	25	25
Aspergillus fumigatus	-	5	5	-	-	-	-	10	10	-	-	-	-	10	5	-	-	-	-	25	25	-	-	-
A. flavus	40	30	30	40	35	30	35	30	25	45	[illegible]	[illegible]	40	35	30	35	35	25	50	50	45	35	45	50
A. niger	35	25	20	30	[illegible]	40	25	20	20	25	30	[illegible]	35	20	20	30	35	40	35	30	25	35	40	45
A. funiculosus	10	15	25	30	30	35	25	35	45	35	[illegible]	40	20	30	40	30	30	35	30	35	35	40	40	40
A. terreus	-	-	-	10	15	-	-	-	-	10	10	-	-	-	-	30	20	10	-	-	-	35	35	30
A. luchuensis	-	-	-	10	10	10	-	-	-	15	10	10	-	-	-	10	15	10	-	-	-	35	35	40
A. candidus	-	-	-	-	10	15	-	-	-	15	15	20	-	-	-	15	20	30	-	-	-	25	20	30
A. sparsus	-	5	5	-	-	-	-	5	-	-	-	-	-	20	15	-	-	-	-	25	30	-	-	-
A. flavipes	-	-	10	20	25	20	-	5	10	15	15	10	[illegible]	5	10	10	10	5	10	20	30	25	30	30
Monosporium olivaceum	20	15	15	-	5	10	20	15	10	10	5	10	20	15	10	10	5	5	30	35	45	20	20	25
Botrytis cinerea	-	-	-	-	10	10	-	-	-	-	-	-	10	10	10	-	-	-	10	20	30	-	-	-
Torulla allii	-	-	-	-	-	-	-	-	-	-	-	-	15	10	10	-	-	-	15	20	35	-	-	-
Sepdonium chrysospermum	10	5	-	-	-	5	-	-	-	-	-	-	-	-	-	-	10	10	-	-	-	-	20	25
Botryotrichum pulluliferum	-	-	-	-	-	5	-	-	-	5	-	-	-	-	5	-	-	-	-	-	20	-	-	-
Spicaria silvatica	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	20	-	-	-	-	-	25	15	-
Cladosporium herbarum	15	20	20	20	20	15	15	20	25	20	20	15	20	20	20	15	20	25	20	25	35	25	35	45
Trichosporium fuscum	25	-	-	10	-	-	15	-	-	15	-	-	-	-	20	-	-	30	-	-	20	-	-	20
Humicola fuscotra	-	5	5	-	-	-	-	5	10	-	-	-	-	-	-	10	-	-	-	10	10	-	-	-
Memnoniella echinata	10	10	15	-	-	-	10	10	15	-	-	-	-	-	-	20	-	-	-	25	25	-	-	-
Drechslera hawaiensis	-	20	25	-	15	10	-	30	25	-	15	10	-	-	-	15	10	5	-	35	35	-	30	40
Curvularia lunata	-	15	25	-	5	5	20	15	10	-	20	15	-	20	15	-	10	10	20	35	40	-	30	35
C. geniculata	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	-	10	-	-	-	-	-	25
Alternaria alternata	15	15	10	15	20	20	15	10	10	15	15	[illegible]	15	20	15	15	20	20	25	25	35	25	30	35
Fusarium moniliformae	-	-	-	-	-	10	-	-	-	-	5	10	-	-	-	-	10	15	-	-	-	-	30	35
F. oxysporum	-	-	-	-	10	-	-	-	-	-	5	10	-	-	-	-	10	5	-	-	-	-	15	15
F. oxysporum f. sp. ciceri	45	25	-	-	-	-	55	50	25	-	-	-	[illegible]	[illegible]	[illegible]	-	-	-	70	75	90	-	-	-
Acrophialophora fusispora	-	20	15	-	-	5	-	10	5	-	15	-	-	-	-	-	-	-	-	25	25	-	15	10
Trichoderma viridae	-	-	-	-	-	-	-	-	-	15	15	15	-	-	-	15	10	10	-	-	-	20	30	40
Sclerotium rolfsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	25	-	-	-
Rhizoctonia solani	-	5	5	-	-	5	-	-	-	-	-	-	-	5	-	-	-	-	-	20	30	-	-	-
Sterile brown mycelium	-	-	5	-	-	5	-	-	-	-	-	-	-	10	10	-	-	-	-	30	45	-	-	-
Sterile black mycelium	5	5	-	-	-	-	25	25	35	-	-	-	20	20	20	-	-	-	30	45	45	-	-	-
	-	-	-	10	10	15	-	-	-	10	10	10	-	-	-	10	15	20	-	-	-	40	45	50

TABLE 2 - (i): Fungi (percent per) of the rhizoplane of chickpea plants cultivar Di-6 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri sprayed with growth regulators and fertilizers

Fungi isolated	CONTROL						INDOLE ACITIC ACID						INDOLE BUTYRIC ACID						THIO INDOLE BUTYRIC ACID					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I+	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	35	25	20	[illegible]	30	35	35	[illegible]	35	30	35	55	30	25	45	30	45	40	55	60	65	30	35	40
Cunninghamella echinulata	15	20	20	-	-	-	25	30	40	-	-	-	20	25	30	-	-	-	15	20	25	-	-	-
Mucor racemosus	10	15	30	-	-	-	15	20	35	-	-	-	15	25	30	-	-	-	15	25	35	-	-	-
Chaetomium flavum	10	15	25	15	20	30	15	20	30	20	20	35	15	20	30	-	30	45	15	20	30	15	20	35
Macrophomina phaseolina	-	-	20	-	-	-	-	-	25	-	-	-	-	5	30	-	-	-	-	-	30	-	-	-
Mortierilla alpina	15	15	25	-	-	-	10	20	30	-	-	-	15	20	30	-	-	-	20	20	30	-	-	-
Cephalosporium aspermum	-	-	-	15	20	30	-	-	-	30	35	40	-	-	-	20	25	35	-	-	-	30	40	45
Aspergillus fumigatus	45	35	40	45	25	30	55	60	60	50	45	50	65	60	65	55	45	65	65	60	60	45	55	55
A. flavus	45	30	25	35	40	50	40	45	30	45	50	50	45	40	45	45	50	60	45	40	40	50	55	60
A. niger	20	20	25	20	25	30	30	40	45	20	30	40	30	25	25	20	30	35	25	25	40	25	30	35
A. terreus	-	-	-	-	15	15	-	-	-	-	15	25	-	-	-	10	15	20	-	-	-	-	15	20
A. luchuensis	-	-	-	20	20	25	-	-	-	25	30	35	-	-	-	20	25	30	-	-	-	20	25	30
A. candidus	-	15	25	-	-	-	-	15	35	-	-	-	-	10	30	-	-	-	-	15	30	-	-	-
A. flavipes	20	25	30	20	20	25	30	35	40	25	30	35	20	30	35	20	25	30	25	30	45	20	20	30
A. sparsus	15	25	25	20	25	30	15	20	40	20	30	35	10	15	30	20	25	35	15	20	30	25	30	30
Monosporium olivaceum	10	15	20	-	-	-	25	30	35	-	-	-	25	30	45	-	-	-	20	30	50	-	-	-
Botrytis cinerea	-	20	25	-	-	-	-	20	40	-	-	-	-	30	30	-	-	-	-	25	35	-	-	-
Cladosporium herbarum	25	30	35	15	15	20	25	35	45	20	20	25	25	30	40	20	25	30	25	30	35	15	20	30
Humicola fuscotra	-	-	-	-	10	15	-	-	-	15	20	20	-	-	-	-	20	25	-	-	-	-	20	30
Hemnoniella echinata	-	-	-	10	15	20	-	-	-	15	20	20	-	-	-	10	20	30	-	-	-	20	25	30
Drechslera hawaiensis	-	20	20	-	10	15	30	30	35	-	15	20	20	25	25	-	15	30	30	25	25	-	15	25
Curvularia lunata	-	15	20	-	10	15	15	15	25	-	10	20	20	25	30	-	20	30	15	20	30	-	20	25
Alternaria alternata	20	25	30	10	10	15	20	25	30	10	15	25	25	30	35	15	15	25	25	40	45	15	10	20
Fusarium oxysporum	-	-	-	20	10	15	-	-	-	20	20	25	-	-	-	25	25	25	-	-	-	25	20	20
F. oxysporum f.sp. ciceri	50	60	70	-	-	-	70	80	85	-	-	-	60	75	80	-	-	-	55	65	75	-	-	-
Acrophialophora fusipora	-	20	25	-	-	-	-	25	35	-	-	-	-	20	30	-	-	-	-	25	30	-	-	-
Trichoderma viridae	-	-	-	15	20	25	-	-	-	20	30	35	-	-	-	15	30	35	-	-	-	20	30	35
Sclerotium rolfeii	-	-	15	-	-	15	-	-	20	-	-	20	-	-	15	-	-	15	-	-	20	-	-	20
Rhizoctonia solani	-	-	10	-	-	-	-	-	20	-	-	-	-	-	10	-	-	-	-	-	15	-	-	-
Sterile brown mycelium	20	20	20	-	-	-	30	45	45	-	-	-	25	30	40	-	-	-	25	30	35	-	-	-
Sterile black mycelium	-	-	-	[illegible]	30	35	-	-	-	30	40	45	-	-	-	30	30	[illegible]	-	-	-	[illegible]	35	40

Fungi isolated	GIBBERELLIC ACID						MALEIC HYDRAZIDE						UREA						MURIATE OF POTASH					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	35	30	25	30	35	45	30	20	15	25	20	20	40	35	50	35	40	45	40	30	35	30	35	[illegible]
Cunninghamella echinulata	25	30	35	-	-	-	10	15	10	-	-	-	25	35	40	-	-	-	20	25	30	-	-	-
Mucor racemosus	15	25	35	-	-	-	10	10	10	-	-	-	15	25	35	-	-	-	15	25	40	-	-	-
Chaetomium flavum	15	30	30	15	20	35	15	15	10	20	20	15	15	25	40	15	20	35	10	20	30	15	25	[illegible]
Macrophomina phaseolina	-	10	40	-	-	-	-	-	5	-	-	-	-	-	25	-	-	-	-	10	20	-	-	-
Mortierilla alpina	20	30	40	-	-	-	-	15	15	-	-	-	15	20	30	-	-	-	15	20	35	-	-	-
Cephalosporium aspermum	-	-	-	25	35	50	-	-	-	15	15	20	-	-	-	25	30	40	-	-	-	15	25	30
Aspergillus fumigatus	65	60	50	50	50	45	50	45	40	40	20	10	50	60	50	50	45	65	45	45	50	40	40	45
A. flavus	50	40	35	40	50	60	40	30	25	25	35	30	55	40	40	50	50	60	50	50	50	40	50	60
A. niger	25	25	20	25	30	45	20	10	5	25	35	45	30	35	35	20	30	40	30	35	40	25	30	45
A. terreus	-	-	-	-	15	20	-	-	-	-	15	20	-	-	-	-	20	25	-	-	-	-	25	35
A. luchuensis	-	-	-	20	30	35	-	-	-	15	10	10	-	-	-	20	25	30	-	-	-	25	25	30
A. candidus	-	15	35	-	-	-	-	-	-	-	-	-	-	20	30	-	-	-	-	20	25	-	-	-
A. flavipes	25	30	40	25	25	30	10	15	20	15	10	5	25	35	40	25	25	30	15	25	30	20	25	30
A. sparsus	15	25	35	20	25	30	[illegible]	10	15	[illegible]	15	10	15	15	25	25	35	35	25	30	40	15	20	[illegible]
Monosporium olivaceum	25	30	40	-	-	-	20	15	15	-	-	-	25	30	40	-	-	-	25	35	35	-	-	-
Botrytis cinerea	-	20	25	-	-	-	-	-	-	-	-	-	-	15	25	-	-	-	-	15	20	-	-	-
Cladosporium herbarum	25	30	30	15	25	30	25	20	15	15	10	10	30	35	40	15	30	40	30	40	50	15	20	25
Humicola fuscotra	-	-	-	-	20	25	-	-	-	-	5	-	-	-	-	-	20	25	-	-	-	-	-	-
Hemnoniella echinata	-	-	-	20	25	35	-	-	-	5	5	-	-	-	-	15	25	30	-	-	-	15	25	40
Drechslera hawaiensis	20	30	40	-	10	20	25	15	15	-	5	5	25	25	35	-	15	25	20	20	25	-	10	10
Curvularia lunata	20	25	35	-	25	30	20	10	15	-	5	-	20	25	30	-	20	30	15	10	15	-	15	15
Alternaria alternata	25	35	40	15	20	30	10	15	15	5	5	5	25	35	35	10	10	20	20	15	15	-	10	10
Fusarium oxysporum	-	-	-	25	25	30	-	-	-	25	25	30	-	-	10	15	10	20	-	-	-	-	5	10
F. oxysporum f.sp. ciceri	70	80	85	-	-	-	40	40	45	-	-	-	60	65	75	-	-	-	55	50	60	-	-	-
Acrophialophora fusipora	-	25	30	-	-	-	-	5	5	-	-	-	-	20	30	-	-	-	-	15	15	-	-	-
Trichoderma viridae	-	-	-	20	30	35	-	-	-	[illegible]	15	15	-	-	-	20	25	35	-	-	-	25	35	45
Sclerotium rolfeii	-	-	20	-	-	25	-	-	10	-	-	5	-	10	25	-	-	[illegible]	-	-	10	-	-	[illegible]
Rhizoctonia solani	-	15	25	-	-	-	-	-	[illegible]	-	-	-	-	-	15	-	-	-	-	-	5	-	-	-
Sterile brown mycelium	25	30	30	-	-	-	15	10	15	-	-	-	20	25	35	-	-	-	25	25	[illegible]	-	-	-
Sterile black mycelium	-	-	-	30	35	40	-	-	-	[illegible]	20	15	-	-	-	30	[illegible]	[illegible]	-	-	-	[illegible]	[illegible]	

IP = Inoculated plants, UP = Uninoculated plants

+ [illegible]

TABLE - 16: Frequency (percentage) of fungi in the rhizosphere of chickpea plants cultivar JG-74 uninoculated and inoculated with *Fusarium oxysporum* f.sp. *ciceri* with growth regulators and fetilizers

Fungi isolated	CONTROL						INDOLE ACITIC ACID						INDOLE BUTYRIC ACID						THIO INDOLE BUTYRIC ACID						GIBBERELLIC ACID						MALEIC HYDRAZIDE						UREA						MURIATE OF POTASH					
	IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP			IP			UP		
	I+	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	20	30	40	-	-	-	35	45	50	-	-	-	30	40	45	-	-	-	25	40	45	-	-	-	35	40	50	-	-	-	30	25	30	-	-	-	40	45	50	-	-	-	35	40	45
R. nodosus	30	25	20	10	15	20	35	30	25	10	20	25	30	30	25	15	15	25	40	50	60	10	15	25	35	30	25	15	20	25	25	25	15	-	10	10	30	30	35	10	20	25	35	30	30	15	25	35
Cunninghamella echinulata	15	15	20	-	-	-	20	25	30	-	-	-	20	20	25	-	-	-	20	20	25	-	-	-	15	20	25	-	-	-	15	10	10	-	-	-	15	20	25	-	-	-	15	25	25	-	-	-
Mucor globosus	10	10	15	-	15	15	15	15	25	-	15	20	15	20	25	-	15	15	15	20	20	-	20	20	15	20	35	-	20	25	10	5	5	-	15	10	10	15	20	-	20	25	10	10	15	-	15	20
Mortierilla alpina	20	20	25	-	-	-	25	35	45	-	-	-	20	30	35	-	-	-	25	25	30	-	-	-	20	25	30	-	-	-	20	15	10	-	-	-	20	25	35	-	-	-	20	25	30	-	-	-
Monilia humicola	-	20	30	-	20	25	-	25	35	-	20	30	-	25	30	-	25	30	-	30	30	-	30	35	-	30	40	-	25	35	-	20	20	-	25	20	-	25	35	-	20	25	-	25	30	-	20	30
Cephalosporium aspermum	-	-	-	-	15	25	-	-	-	15	30	45	-	-	-	10	20	30	-	-	-	-	20	30	-	-	-	-	25	30	-	-	-	-	15	20	-	-	-	15	25	45	-	-	-	-	25	35
Chaetomium flavum	-	20	20	-	-	-	-	20	25	-	-	-	-	25	25	-	-	-	-	25	30	-	-	-	-	20	20	-	-	-	-	20	15	-	-	-	-	25	30	-	-	-	-	15	15	-	-	-
Phoma hibernica	-	10	15	15	10	15	10	15	25	20	20	25	-	15	20	10	20	20	-	15	20	20	25	30	10	15	25	20	20	35	-	15	15	15	10	10	15	20	30	15	20	20	15	25	25	20	20	25
Aspergillus funigatus	40	35	30	40	30	30	60	45	40	45	45	40	60	50	40	60	60	60	60	60	55	55	60	60	70	60	55	60	55	50	55	45	40	40	25	20	60	45	35	55	50	55	60	50	45	65	50	45
A. flavus	30	20	15	25	30	40	50	45	40	30	40	50	30	45	40	25	25	20	55	55	50	50	60	70	40	40	40	60	70	75	40	35	10	40	35	35	55	50	40	40	50	60	50	40	25	25	35	45
A. niger	20	30	40	30	40	55	50	45	40	45	55	65	30	40	35	25	20	25	20	55	55	65	70	75	60	50	40	70	75	65	50	45	35	55	50	45	60	45	50	50	55	70	40	50	65	50	60	70
A. terreus	20	20	15	30	35	40	30	25	20	30	40	50	20	20	20	20	35	35	15	25	20	30	40	45	20	25	20	35	45	50	20	15	10	30	25	20	25	25	25	35	40	50	25	30	35	35	40	50
A. luchuensis	-	-	-	15	20	25	-	-	-	20	25	30	-	-	-	15	25	35	-	-	-	25	30	35	-	-	-	15	20	20	-	-	-	15	15	15	-	-	-	20	30	40	-	-	-	20	30	35
A. candidus	-	15	15	-	-	-	-	20	30	-	-	-	-	15	20	-	-	-	-	15	20	-	-	-	-	15	25	-	-	-	-	10	-	-	-	-	-	15	20	-	-	-	-	10	15	-	-	-
A. clavatus	20	15	10	25	25	35	25	20	20	30	30	40	25	30	30	25	35	45	25	25	20	20	30	40	25	20	15	25	35	50	10	5	-	15	15	20	25	20	25	25	35	45	25	20	20	30	40	50
A. sparsus	-	-	-	15	15	20	-	-	-	15	25	30	-	-	-	20	20	30	-	-	-	15	25	30	-	-	-	20	20	25	-	-	-	15	15	15	-	-	-	15	20	25	-	-	-	15	20	30
A. flavipes	25	25	20	-	-	-	20	20	15	-	-	-	25	20	35	-	-	-	25	20	15	-	-	-	25	25	30	-	-	-	20	25	25	-	-	-	25	30	35	-	-	-	25	25	25	-	-	-
Penicillium notatum	15	20	30	30	35	40	30	30	40	40	45	50	15	30	35	35	40	45	20	30	40	35	40	45	25	30	40	40	45	50	15	15	10	15	20	20	20	30	40	30	40	55	20	25	35	30	35	45
Gliocladium roseum	25	30	35	35	40	45	40	45	60	45	50	60	25	30	40	30	35	50	30	35	40	45	45	55	25	25	30	40	45	50	15	15	10	20	25	25	40	40	50	35	45	60	25	35	45	40	45	50
Monosporium olivaceum	10	20	20	-	-	-	15	25	30	-	-	-	15	20	25	-	-	-	15	25	35	-	-	-	10	20	25	-	-	-	10	15	10	-	-	-	15	25	30	-	-	-	15	25	25	-	-	-
Torulla allii	-	-	-	20	20	25	-	-	-	20	25	30	-	-	-	25	25	30	-	-	-	20	25	30	-	-	-	25	30	35	-	-	-	20	15	10	-	-	-	25	25	35	-	-	-	20	25	35
Verticillium glaucum	20	20	30	-	-	-	25	30	35	-	-	-	20	25	35	-	-	-	20	25	35	-	-	-	15	25	35	-	-	-	10	10	15	-	-	-	15	25	35	-	-	-	20	25	35	-	-	-
Cladosporium herbarum	25	30	35	15	20	25	40	45	55	30	35	40	25	40	50	30	35	40	10	15	20	30	35	40	15	20	30	30	40	50	15	10	10	20	20	15	25	30	40	25	35	40	25	25	25	25	25	40
Fusicola fuscotra	-	-	-	-	15	20	-	-	-	-	20	30	-	-	-	-	20	35	-	-	-	10	20	30	-	-	-	-	20	30	-	-	-	-	15	15	-	-	-	-	15	25	-	-	-	-	15	25
Memnoniella echinata	25	20	15	20	25	35	20	25	20	25	30	40	15	20	20	25	30	40	25	20	10	25	30	40	30	25	25	30	40	50	20	15	10	20	15	20	30	30	30	25	30	45	30	35	30	25	35	55
Drechslera hawaiensis	-	35	35	-	25	35	-	35	30	20	40	50	-	45	35	30	40	50	-	40	40	35	40	50	-	30	30	35	45	50	-	20	10	-	25	15	10	35	40	-	25	30	-	35	30	-	25	30
D. sativum	-	-	-	-	-	20	-	-	-	-	15	25	-	-	-	-	-	25	-	-	-	-	-	30	-	-	-	10	25	35	-	-	-	-	-	10	-	-	-	-	-	25	-	-	-	-	-	30
Curvularia lunata	25	40	40	15	30	35	25	45	50	20	35	40	10	15	15	15	30	40	10	35	65	30	30	40	30	45	50	25	35	45	10	15	20	15	15	15	25	30	40	25	35	45	15	20	25	15	30	35
Alternaria alternata	20	25	20	-	-	-	20	25	25	-	-	-	15	20	25	-	-	-	20	35	30	-	-	-	25	30	30	-	-	-	10	15	15	-	-	-	20	25	30	-	-	-	20	20	15	-	-	-
A. humicola	-	-	-	15	20	25	-	-	-	25	30	35	-	-	-	25	35	50	-	-	-	20	25	30	-	-	-	25	40	45	-	-	-	10	15	10	-	-	-	25	30	40	-	-	-	15	25	30
Fusarium moniliformae	-	-	-	-	-	15	-	-	-	-	-	20	-	-	-	-	10	20	-	-	-	-	10	20	-	-	-	-	-	20	-	-	-	-	-	5	-	-	10	-	20	30	-	-	-	-	-	10
F. oxysporum f.sp.*ciceri*	25	35	40	-	-	-	30	35	50	-	-	-	30	35	45	-	-	-	30	30	45	-	-	-	25	30	55	-	-	-	15	20	20	-	-	-	25	35	50	-	-	-	25	30	30	-	-	-
Trichoderma viridae	10	15	20	20	25	40	15	20	30	30	35	45	15	20	30	25	35	65	15	20	25	20	30	45	20	20	30	25	35	50	10	10	10	25	25	20	20	35	50	30	35	55	25	35	50	25	35	60
T. lignorum	-	-	10	-	15	20	-	15	15	10	25	35	-	-	15	-	-	10	-	10	15	-	20	25	-	10	10	-	20	25	-	-	-	-	10	20	-	5	15	-	15	15	-	-	15	-	20	25
Sclerotium rolfsii	-	-	10	-	-	-	-	10	25	-	-	-	-	10	15	-	-	-	-	10	20	-	-	-	-	20	25	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	15	-	-	-
Sterile brown mycelium	10	15	20	-	-	-	20	25	35	-	-	-	15	20	30	-	-	-	25	35	45	-	-	-	25	30	35	-	-	-	5	20	15	-	-	-	25	35	45	-	-	-	20	30	45	-	-	-
Sterile black mycelium	-	-	-	15	20	25	-	-	-	25	30	35	-	-	-	20	25	30	-	-	-	15	20	30	-	-	-	25	35	40	-	-	-	15	15	15	-	-	-	25	30	35	-	-	-	25	35	45

TABLE - 15: Frequency (percentage) of fungi in the rhizoplane of chickpea plants cultivar JG-62 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri sprayed with pesticides

Fungi isolated	CONTROL						BAVISTIN						VITAVAX						BRASSICOL					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I+	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	35	25	20	25	30	5	30	30	35	25	20	20	35	35	30	15	20	20	35	30	20	20	25	20
Cunninghamella echinulata	15	20	20	-	-	-	20	25	30	-	-	-	20	25	25	-	-	-	20	25	25	-	-	-
Mucor racemosus	10	15	30	20	20	35	20	20	25	-	-	-	15	25	30	-	-	-	15	25	40	-	-	-
Chaetomium flavum	10	15	25	15	20	30	10	10	10	15	15	20	-	10	10	10	15	15	15	15	15	20	20	25
Macrophomina phaseolina	-	-	20	-	-	-	-	-	10	-	-	-	-	-	10	-	-	-	-	-	5	-	-	-
Mortierilla alpina	15	15	25	-	-	-	10	10	15	-	-	-	10	5	-	-	-	-	10	10	20	-	-	-
Cephalosporium aspermum	-	-	-	15	20	30	-	-	-	15	15	10	-	-	-	10	10	5	-	-	-	15	15	20
Aspergillus fumigatus	45	35	40	45	25	30	55	50	45	40	40	40	55	45	35	40	40	35	45	50	55	40	40	35
A. flavus	45	30	25	35	40	50	50	40	30	30	30	25	35	40	35	30	25	25	30	35	35	30	35	35
A. niger	20	20	25	20	25	30	25	30	35	15	20	15	25	25	30	20	20	20	20	25	20	15	10	10
A. terreus	-	-	-	-	15	15	-	-	-	-	15	5	-	-	-	-	5	5	-	-	-	-	-	5
A. luchuensis	-	-	-	20	20	25	-	-	-	15	15	15	-	-	-	20	10	5	-	-	-	-	5	5
A. candidus	-	15	25	-	-	-	-	15	15	-	-	-	-	20	25	-	-	-	-	10	10	-	-	-
A. flavipes	20	25	30	20	20	25	15	15	10	20	10	10	15	10	5	15	10	10	15	15	10	5	5	5
A. sparsus	15	15	25	20	25	30	10	10	15	20	20	10	10	15	10	25	20	15	10	10	10	25	20	15
Monosporium olivaceum	10	15	20	-	-	-	10	15	10	-	-	-	20	20	15	-	-	-	15	15	20	-	-	-
Botrytis cinerea	-	20	25	-	-	-	-	10	10	-	-	-	-	10	5	-	-	-	-	15	15	-	-	-
Cladosporium herbarum	25	30	35	15	15	20	20	20	25	10	15	20	25	35	35	15	10	10	20	25	25	10	10	10
Humicola fuscotra	-	-	-	-	10	15	-	-	-	-	5	10	-	-	-	-	5	5	-	-	-	-	15	15
Memnoniella echinata	-	-	-	10	15	20	-	-	-	5	10	15	-	-	-	10	10	10	-	-	-	10	10	15
Drechslera hawaiensis	-	20	20	-	10	15	-	15	10	-	10	10	-	25	15	-	10	5	-	15	15	-	15	5
Curvularia lunata	-	15	20	-	10	15	-	10	10	-	5	5	-	10	10	-	10	10	-	5	10	-	5	5
Alternaria alternata	20	25	30	10	10	15	15	10	10	-	5	5	15	15	10	-	15	15	15	20	25	-	10	10
Fusarium oxysporum	-	-	-	20	10	15	-	-	-	-	-	10	-	-	-	-	10	10	-	-	-	-	5	10
F. oxysporum f.sp. ciceri	50	60	70	-	-	-	25	25	-	-	-	-	45	40	30	-	-	-	40	35	10	-	-	-
Acrophialophora fusispora	-	20	25	-	-	-	-	10	10	-	-	-	-	15	15	-	-	-	-	15	10	-	-	-
Trichoderma viridae	-	-	-	15	20	25	-	-	-	10	10	10	-	-	-	15	15	10	-	-	-	15	10	10
Sclerotium rolfsii	-	-	15	-	-	15	-	-	5	-	-	5	-	-	-	-	-	10	-	-	5	-	-	5
Rhizoctonia solani	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sterile brown mycelium	20	20	20	-	-	-	10	15	10	-	-	-	15	10	10	-	-	-	15	15	10	-	-	-
Sterile black mycelium	-	-	-	25	30		-	-	-	25	20	15	-	-	-	20	20	15	-	-	-	20	15	15

Fungi isolated	BENLATE						CAPTAN						WETTABLE SULPHUR						SEPTOMYCIN					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	25	15	10	25	25	15	35	40	40	20	20	15	30	20	15	30	25	20	40	30	[illegible]			
Cunninghamella echinulata	10	15	20	-	-	-	20	20	15	-	-	-	15	10	15	-	-	-	20	25	[illegible]	-	-	-
Mucor racemosus	10	10	10	-	-	-	15	15	20	-	-	-	15	25	35	-	-	-	15	25	40	-	-	-
Chaetomium flavum	-	10	5	-	15	10	-	10	5	-	15	15	10	10	10	15	20	20	20	25	25	15		
Macrophomina phaseolina	-	-	5	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	20	35	-	-	-
Mortierilla alpina	10	10	10	-	-	-	-	10	10	-	-	-	10	5	5	-	-	-	25	25	35	-	-	-
Cephalosporium aspermum	-	-	-	15	10	10	-	-	-	15	10	15	-	-	-	10	15	15	-	-	-	20	30	[illegible]
Aspergillus fumigatus	50	40	30	40	35	35	50	45	40	40	35	30	50	50	40	40	45	50	65	60	60	50	50	70
A. flavus	35	35	30	30	25	20	45	35	20	30	25	25	50	40	25	35	35	40	50	45	35	35	45	35
A. niger	25	25	20	15	10	10	25	30	30	20	15	15	20	25	30	15	20	15	30	25	20	25	35	45
A. terreus	-	-	-	-	-	5	-	-	-	-	10	5	-	-	-	-	5	5	-	-	-	-	15	20
A. luchuensis	-	-	-	10	5	-	-	-	-	20	15	5	-	-	-	20	20	20	-	-	-	20	25	30
A. candidus	-	10	5	-	-	-	-	10	15	-	-	-	10	15	10	-	-	-	-	25	35	-	-	-
A. flavipes	15	10	10	20	15	15	20	15	10	10	5	5	15	15	10	15	10	5	30	35	40	25	30	35
A. sparsus	10	10	15	15	20	25	20	10	10	25	25	10	10	10	10	10	15	10	20	30	45	20	30	35
Monosporium olivaceum	15	10	10	-	-	-	10	15	15	-	-	-	15	10	15	-	-	-	30	35	35	-	-	-
Botrytis cinerea	15	10	10	-	-	-	-	10	5	-	-	-	15	10	10	-	-	-	25	30	30	-	-	-
Cladosporium herbarum	5	10	10	15	10	10	25	25	25	10	10	5	25	25	30	15	10	10	35	40	35	20	25	35
Humicola fuscotra	-	-	-	-	15	10	-	-	-	-	5	5	-	-	-	-	5	5	-	-	-	-	-	20
Memnoniella echinata	-	-	-	10	5	-	-	-	-	10	10	10	-	-	-	5	5	10	-	-	-	[illegible]	30	30
Drechslera hawaiensis	-	15	15	-	15	10	-	20	15	-	10	10	-	15	5	-	5	5	-	20	25	-	20	25
Curvularia lunata	-	10	5	-	5	5	-	10	-	-	10	10	-	5	-	-	5	5	-	25	30	-	20	30
Alternaria alternata	15	15	10	-	10	10	15	20	10	-	5	15	15	10	10	-	10	10	30	35	30	-	[illegible]	[illegible]
Fusarium oxysporum	-	-	-	-	10	10	-	-	-	-	15	10	-	-	-	-	5	-	-	-	-	-	15	30
F. oxysporum f.sp. ciceri	35	20	-	-	-	-	45	50	25	-	-	-	40	45	20	-	-	-	65	60	70	-	-	-
Acrophialophora fusispora	-	10	5	-	-	5	-	10	5	-	-	-	-	15	15	-	-	-	-	20	30	-	-	-
Trichoderma viridae	-	-	-	10	10	5	-	-	-	15	10	5	-	-	-	10	15	10	-	-	-	15	25	30
Sclerotium rolfsii	-	-	-	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	-	-	-	-
Rhizoctonia solani	-	-		-	-	-	-	-	-	-	-	5	-	-	-	-	-	5	-	-	25	-	-	-
Sterile brown mycelium	15	15	10	-	-	-	25	30	40	-	-	-	15	15	10	-	-	-	-	-	[illegible]	-	-	-
Sterile black mycelium	-	-	-	10	10	15	-	-	-	20	15	15	-	-	-	20	15	15	-	-	-	[illegible]	[illegible]	[illegible]

IP = Inoculated plants, UP = Uninoculated plants

+Number of [illegible]

TABLE - 17: Frequency of fungi in the rhizosphere of chickpea plants cultivar JG-74 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri sprayed with pesticides

Fungi isolated	CONTROL						BAVISTIN						VITAVAX						BRASSICOL					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I+	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	20	30	40	-	-	-	30	30	35	-	-	-	30	25	25	-	-	-	20	25	30
R. nodosus	30	25	20	10	15	20	30	20	20	5	5	5	25	20	15	10	10	10	25	20	15	10	10	10
Cunninghamella echinulata	15	15	20	-	-	-	10	10	10	-	-	-	10	10	15	-	-	-	15	15	15	-	-	-
Mucor globosus	10	10	15	-	15	15	10	15	20	-	15	10	10	15	25	-	10	10	5	10	10	-	10	15
Mortierilla alpina	20	20	25	-	-	-	20	15	15	-	-	-	15	10	10	-	-	-	20	15	15	-	-	-
Monilia humicola	-	20	30	-	20	25	-	15	25	-	10	5	-	15	20	-	15	15	-	20	25	-	15	25
Cephalosporium aspermum	-	-	-	-	15	25	-	-	-	-	15	15	-	-	-	-	10	10	-	-	-	-	10	15
Chaetomium flavum	-	20	20	-	-	-	-	15	15	-	-	-	-	20	10	-	-	-	15	15	-	-	-	-
Phoma hibernica	-	10	15	15	10	15	-	10	15	10	5	5	-	15	25	-	5	5	-	15	20	5	-	-
Aspergillus fumigatus	40	35	30	40	30	30	40	40	45	50	45	40	45	45	50	45	40	30	40	35	35	40	40	45
A. flavus	30	20	15	25	30	40	35	30	20	25	25	30	30	20	10	25	30	35	25	15	15	25	30	30
A. niger	20	30	40	30	40	55	25	35	45	25	30	40	30	40	50	25	35	45	25	30	35	35	40	50
A. terreus	20	20	15	30	35	40	15	25	30	25	35	45	20	25	25	25	20	10	20	25	30	30	40	50
A. luchiensis	-	-	-	15	20	25	-	-	-	20	20	20	-	-	-	15	15	15	-	-	-	10	15	20
A. candidus	-	15	15	-	-	-	-	10	10	-	-	-	-	5	5	-	-	-	-	-	5	-	-	-
A. clavatus	20	15	10	25	25	35	20	25	30	10	15	20	25	25	25	15	10	10	20	20	20	5	10	10
A. sparsus	-	-	-	15	15	20	-	-	-	15	20	25	-	-	-	10	10	15	-	-	-	15	15	20
A. flavipes	25	25	20	-	-	-	20	15	10	-	-	-	20	20	15	-	-	-	25	20	15	-	-	-
Penicillium notatum	15	20	30	30	35	40	15	15	15	30	30	35	10	10	10	35	40	40	10	10	15	20	25	20
Gliocladium roseum	25	30	35	35	40	45	30	25	30	20	25	30	30	25	20	20	30	30	20	20	15	25	25	25
Monosporium olivaceum	10	20	20	-	-	-	10	15	10	-	-	-	10	15	15	-	-	-	10	15	15	-	-	-
Torulla allii	-	-	-	20	20	25	-	-	-	15	10	15	-	-	-	20	15	10	-	-	-	15	15	10
Verticillium glaucum	20	20	30	-	-	-	15	15	25	-	-	-	[illegible]			-	-	-	20	15	10	-	-	-
Cladosporium herbarum	25	30	35	15	20	25	20	25	35	10	15	15	[illegible]			[illegible]			10	15	20	20	20	20
Humicola fuscotra	-	-	-	-	15	20	-	-	-	-	10	10	-	-	-	-	[illegible]		-	-	5	-	-	-
Memnoniella echinata	25	20	15	20	25	35	25	25	20	15	15	20	[illegible]			[illegible]			30	30	30	-	10	15
Drechslera hawaiensis	-	35	35	-	25	25	-	25	10	-	20	15	-	[illegible]		-	[illegible]		-	[illegible]		-	[illegible]		
D. sativum	-	-	-	-	-	20	-	-	-	-	-	10	-	-	-	-	-	5	-	-	-	-	-	-
Curvularia lunata	25	40	40	15	30	35	15	20	20	10	10	15	[illegible]			[illegible]			15	10	10	5	15	15
Alternaria alternata	20	25	20	-	-	-	10	10	10	-	-	-	[illegible]			[illegible]			[illegible]			-	-	-
A. humicola	-	-	-	15	20	25	-	-	-	15	10	10	-	-	-	10	10	10	-	-	-	10	10	15
Fusarium moniliformae	-	-	-	-	-	15	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	-	15
F. oxysporum f.sp.ciceri	25	35	40	-	-	-	15	10	-	-	-	-	[illegible]			-	-	-	15	15	15	-	-	-
Trichoderma viridae	10	15	20	20	25	40	15	20	25	15	20	20	[illegible]			20	15	15	10	10	10	15	10	20
T. lignorum	-	-	10	-	15	20	-	-	15	-	5	10	-	-	-	-	5	5	-	-	5	-	-	10
Sclerotium rolfsii	-	-	10	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Sterile brown mycelium	10	15	20	-	-	-	5	5	10	-	-	-	10	10	10	-	-	-	20	25	30	-	-	-
Sterile black mycelium	-	-	-	15	20	25	-	-	-	15	10	10	-	-	-	10	10	10	-	-	-	15	20	20

Fungi isolated	BENLATE						CAPTAN						WETTABLE SULPHUR						STREPTOMYCIN					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	20	20	25	-	-	-	20	30	30	-	-	-	15	20	25	-	-	-	35	40	45
R. nodosus	15	15	20	-	5	5	35	40	35	10	15	15	25	20	15	-	5	5	40	35	35	15	20	25
Cunninghamella echinulata	10	10	10	-	-	-	10	15	15	-	-	-	10	10	5	-	-	-	20	25	30	-	-	-
Mucor globosus	10	5	-	-	5	5	10	10	15	-	15	15	-	5	5	-	15	10	15	15	25	-	15	20
Mortierilla alpina	-	15	10	-	-	-	15	10	10	-	-	-	15	15	15	-	-	-	20	25	30	-	-	-
Monilia humicola	-	15	25	-	20	20	-	20	30	-	15	20	-	25	30	-	20	25	-	25	35	-	25	30
Cephalosporium aspermum	-	-	-	-	10	20	-	-	-	-	10	10	-	-	-	-	15	20	-	-	-	-	25	35
Chaetomium flavum	-	10	10	-	-	-	-	15	10	-	-	-	-	-	-	-	15	20	-	-	-	-	-	-
Phoma hibernica	-	15	20	15	5	5	-	-	15	15	10	10	-	-	-	5	5	-	10	10	20	20	20	30
Aspergillus fumigatus	50	45	40	40	40	35	55	45	40	50	45	40	40	35	35	35	30	30	50	45	40	40	45	50
A. flavus	20	15	10	25	25	20	25	15	15	20	25	30	25	15	10	25	30	35	45	35	30	35	10	50
A. niger	20	25	30	35	40	50	25	30	35	40	40	50	25	35	45	30	40	50	40	50	60	30	45	60
A. terreus	15	20	20	35	40	45	20	15	10	25	30	35	15	15	10	25	30	35	25	20	15	35	40	45
A. luchiensis	-	-	-	10	15	15	-	-	-	10	20	20	-	-	-	5	10	15	-	-	-	20	25	30
A. candidus	-	10	5	-	-	-	-	5	5	-	-	-	-	15	20	-	-	-	-	15	25	-	-	-
A. clavatus	15	10	5	20	10	15	15	10	-	15	10	-	20	30	40	15	15	10	35	30	30	30	40	50
A. sparsus	-	-	-	10	15	20	-	-	-	15	10	10	-	-	-	10	10	10	-	-	-	20	30	30
A. flavipes	25	15	15	-	-	-	[illegible]			-	-	-	20	15	15	-	-	-	30	30	30	-	-	-
Penicillium notatum	15	10	15	20	20	20	15	20	25	25	35	35	30	30	40	35	40	40
Gliocladium roseum	25	20	15	20	20	25	20	25	25	25	30	35	35	40	40	35	45	55
Monosporium olivaceum	-	10	10	-	-	-	15	15	15	-	-	-	15	20	25	-	-	-	-	-	-	-	-	-
Torulla allii	-	-	-	10	10	10	-	-	-	15	10	10	-	-	-	15	10	15	-	-	-	20	25	30
Verticillium glaucum	15	10	10	-	-	-	20	15	15	-	-	-	15	15	10	-	-	-	25	30	35	-	-	-
Cladosporium herbarum	[illegible]			5	10	-	20	25	30	20	20	20	20	25	25	5	15	20	30	30	40	20	30	35
Humicola fuscotra	-	-	-	-	15	15	-	-	-	-	10	15	-	-	-	5	10	15	-	-	-	-	25	35
Memnoniella echinata	[illegible]			10	15	15	25	20	20	20	25	25	20	15	10	15	15	20	30	30	25	30	35	45
Drechslera hawaiensis	-	[illegible]		-	10	15	-	30	35	-	15	10	-	30	25	-	25	15	-	40	30	-	20	20
D. sativum	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-	10	-	-	-	-	-	15
Curvularia lunata	[illegible]			5	15	15	20	25	25	15	20	20	20	10	15	20	15	20	25	25	35	45	25	25
Alternaria alternata	[illegible]			-	-	-	15	15	10	-	-	-	20	10	15	-	-	-	20	25	30	-	-	-
A. humicola	-	-	-	10	10	15	-	-	-	15	10	15	-	-	-	20	20	20	-	-	-	15	25	30
Fusarium moniliformae	-	-	15	-	-	5	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	-	10
F. oxysporum f.sp.ciceri	20	-	-	-	-	-	25	25	20	-	-	-	20	20	20	-	-	-	25	30	35	-	-	-
Trichoderma viridae	20	20	25	15	20	25	15	20	20	15	20	25	20	20	25	20	20	25	15	25	35	25	35	50
T. lignorum	-	-	10	-	-	10	-	5	5	-	15	15	-	-	10	-	10	10	-	-	10	-	20	30
Sclerotium rolfsii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	5	15	-	-	-
Sterile brown mycelium	20	30	40	-	-	-	15	25	35	-	-	-	25	30	35	-	-	-	25	30	35	-	-	-
Sterile black mycelium	-	-	-	25	20	20	-	-	-	15	15	10	-	-	-	10	10	15	-	-	-	25	35	40

+Number of spray

IP = Inoculated plants, UP = Uninoculated plants

TABLE - 18 : Frequency (percentage) of fungi in the rhizoplane of chickpea plants cultivar JG-74 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri sprayed with growth regulators and fertilizers

Fungi isolated	CONTROL						INDOLE ACITIC ACID						INDOLE BUTYRIC ACID						THIO INDOLE BUTYRIC ACID					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I+	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	20	25	30	-	-	-	40	45	60	-	-	-	30	35	45	-	-	-	25	35	45
R. nodosus	15	10	10	15	25	30	20	25	20	15	25	50	25	20	20	25	30	35	25	20	25	15	25	35
Cunninghamella echinulata	15	20	20	-	-	-	25	25	30	-	-	-	25	25	25	-	-	-	25	20	25	-	-	-
Mucor globosus	10	15	20	-	-	-	15	20	30	-	-	-	15	20	30	-	-	-	15	25	30	-	-	-
Mortierilla alpina	10	15	20	-	-	-	20	25	35	-	-	-	15	25	35	-	-	-	20	20	25	-	-	-
Cephalosporium aspermum	-	-	-	25	30	50	-	-	-	60	70	75	-	-	-	40	50	60	-	-	-	45	55	65
Aspergillus fumigatus	50	35	30	40	30	40	70	40	35	60	45	40	65	50	45	55	50	45	55	55	55	65	55	55
A. flavus	40	35	35	35	40	45	60	60	60	40	45	55	45	50	60	40	45	50	50	40	40	40	50	70
A. niger	20	25	40	30	35	50	30	40	50	50	60	70	25	35	50	45	50	65	35	40	60	45	60	60
A. terreus	-	-	-	25	35	45	-	-	-	30	45	50	-	-	-	25	40	50	-	-	-	35	45	50
A. clavatus	20	15	15	20	30	40	20	25	25	30	35	45	25	20	20	25	35	45	25	20	20	25	35	45
A. sparsus	-	-	-	15	20	20	-	-	-	20	30	30	-	-	-	20	25	30	-	-	-	20	25	30
A. flavipes	25	20	20	-	-	-	25	20	10	-	-	-	40	35	25	-	-	-	25	20	15	-	-	-
Gliodadium roseum	20	25	30	25	30	40	25	30	35	20	35	40	20	25	35	30	35	45	30	25	40	45	60	65
Monosporium olivaceum	-	10	15	-	-	-	-	10	20	-	-	-	-	15	20	-	-	-	-	20	25	-	-	-
Cladosporium herbarum	30	35	45	20	25	35	35	40	50	30	40	40	30	40	50	30	40	40	30	40	50	25	35	45
Memnoniella echinata	-	-	20	25	30	40	-	-	30	35	40	45	-	-	25	30	40	50	-	-	25	30	35	45
Trichoderma viridae	25	20	15	25	30	40	25	30	25	30	40	50	25	30	25	30	30	45	25	25	25	25	35	50
Humicola fuscotra	-	-	-	-	15	20	-	-	-	-	[illegible]	25	-	-	-	-	30	35	-	-	-	-	20	30
Fusarium oxysporum f.sp.ciceri	30	35	40	-	-	-	30	40	50	-	-	-	30	40	50	-	-	-	35	40	45	-	-	-
Alternaria alternata	10	15	20	-	-	-	10	20	30	-	-	-	15	25	25	-	-	-	10	20	25	-	-	-
A. humicola	-	-	-	-	10	20	-	-	-	-	20	30	-	-	-	-	15	25	-	-	-	-	15	25
Drechslera hawaiensis	-	30	20	-	15	20	-	[illegible]	[illegible]	-	[illegible]	55	-	35	30	-	20	30	-	35	30	-	20	25
Curvularia lunata	-	30	40	-	20	30	-	[illegible]	[illegible]	-	30	40	-	30	40	-	25	30	-	35	60	-	25	40
Sclerotium rolfsii	-	-	15	-	-	15	-	20	30	-	-	[illegible]	-	15	20	-	-	20	-	10	20	-	-	20
Sterile black mycelium	-	-	-	25	30	35	-	-	-	[illegible]	[illegible]	30	-	-	-	30	40	50	-	-	-	30	35	50
Sterile brown mycelium	25	30	35	-	-	-	35	40	40	-	-	-	35	40	45	-	-	-	40	45	50	-	-	-

Fungi isolated	GIBBERELLIC ACID						MALEIC HYDRAZIDE						UREA						MURIATE OF POTASH					
	IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	25	35	50	-	-	-	20	20	15	-	-	-	30	30	50	-	-	-	15	25	35
R. nodosus	25	25	25	20	30	40	10	5	-	15	10	5	25	25	30	20	30	35	25	20	25	20	30	40
Cunninghamella echinulata	25	30	35	-	-	-	10	15	10	-	-	-	20	25	30	-	-	-	20	25	30	-	-	-
Mucor globosus	20	30	40	-	-	-	5	10	10	-	-	-	10	20	25	-	-	-	15	25	30	-	-	-
Mortierilla alpina	20	25	30	-	-	-	10	10	10	-	-	-	10	20	30	-	-	-	10	10	15	-	-	-
Cephalosporium aspermum	-	-	-	40	50	60	-	-	-	30	30	35	-	-	-	40	50	60	-	-	-	35	45	55
Aspergillus fumigatus	60	55	50	55	45	40	50	40	35	35	25	10	60	55	50	55	50	70	65	60	60	45	35	30
A. flavus	40	55	50	45	55	65	35	30	25	30	30	35	60	50	55	45	50	55	50	50	55	35	45	50
A. niger	25	35	40	30	40	55	25	35	15	40	50	60	25	35	45	50	55	60	35	40	50	40	45	55
A. terreus	-	-	-	30	40	50	-	-	-	30	20	10	-	-	-	30	40	55	-	-	-	40	50	60
A. clavatus	25	20	15	30	40	50	15	10	10	15	20	25	25	30	35	25	40	50	30	30	35	25	35	55
A. sparsus	-	-	-	20	25	35	-	-	-	15	15	15	-	-	-	10	25	35	-	-	-	20	25	30
A. flavipes	35	30	30	-	-	-	15	10	10	-	-	-	15	20	25	-	-	-	25	30	30	-	-	-
Gliodadium roseum	25	30	25	30	40	50	10	15	20	15	20	25	25	35	45	30	40	50	20	25	35	25	35	45
Monosporium olivaceum	-	20	30	-	-	-	-	-	10	-	-	-	-	20	25	-	-	-	-	-	10	-	-	-
Cladosporium herbarum	30	40	55	30	35	45	25	20	25	25	20	15	30	40	50	25	35	45	30	40	30	25	35	45
Memnoniella echinata	-	-	35	25	30	30	-	-	20	15	20	20	-	15	35	25	35	50	-	-	35	40	40	55
Trichoderma viridae	30	25	25	35	40	50	25	10	10	30	25	25	35	30	30	30	35	50	25	30	35	30	35	55
Humicola fuscotra	-	-	-	-	[illegible]	30	-	-	-	-	10	5	-	-	-	-	20	30	-	-	-	-	20	35
Fusarium oxysporum f.sp.ciceri	35	45	45	-	-	-	25	30	10	-	-	-	35	40	50	-	-	-	35	35	35	-	-	-
Alternaria alternata	15	25	35	-	-	-	-	5	5	-	-	-	10	20	25	-	-	-	10	10	10	-	-	-
A. humicola	-	-	-	-	[illegible]	25	-	-	-	-	15	15	-	-	-	-	15	30	-	-	-	-	15	25
Drechslera hawaiensis	-	[illegible]	10	-	[illegible]	30	-	25	20	-	15	10	-	30	30	-	25	25	-	30	25	-	20	30
Curvularia lunata	-	[illegible]	50	-	[illegible]	55	-	15	20	-	10	15	-	30	45	-	25	35	-	25	30	-	30	35
Sclerotium rolfsii	-	[illegible]	35	-	-	25	-	-	5	-	-	-	-	-	25	-	-	20	-	-	5	-	-	-
Sterile black mycelium	-	-	-	30	[illegible]	45	-	-	-	25	25	20	-	-	-	35	35	40	-	-	-	35	35	40
Sterile brown mycelium	[illegible]	40	15	-	-	-	30	[illegible]	20	-	-	-	25	30	50	-	-	-	25	35	45	-	-	-

+Number of spray

IP = Inoculated plants, UP = Uninoculated plants

TABLE - 19: Frequency (persentage) of fungi in the rhizoplane of chickpea plants cultivar JG-74 uninoculated and inoculated with *Fusarium oxysporum* f.sp. *ciceri* sprayed with pesticides

Fungi isolated	CONTROL			BAVISTIN			VITAVAX			BRASSICOL			BENLATE						CAPTAN						WETTABLE SULPHUR						STREPTOMYCIN					
													IP			UP			IP			UP			IP			UP			IP			UP		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Rhizopus oryzae	-	-	-	20	25	30	-	-	-	10	10	10	-	-	-	10	15	20	-	-	-	10	10	10	-	-	-	10	10	10	-	-	-	20	15	15	-	-	-	25	30	35
R. nodosus	15	10	10	15	25	30	20	25	35	25	20	20	20	20	15	15	10	15	10	15	10	10	10	5	10	5	15	15	20	10	15	20	30	10	5	5	15	10	5	10	10	5	20	15	25	20	30	40
Cunninghamella echinulata	15	20	20	-	-	-	20	25	25	-	-	-	25	30	30	-	-	-	20	20	15	-	-	-	10	15	15	-	-	-	20	15	10	-	-	-	10	15	10	-	-	-	25	25	30	-	-	-
Mucor globosus	10	15	20	-	-	-	15	25	30	-	-	-	20	25	30	-	-	-	10	15	15	-	-	-	10	10	10	-	-	-	10	15	20	-	-	-	5	5	10	-	-	-	15	20	25	-	-	-
Mortierilla alpina	10	15	20	-	-	-	10	10	10	-	-	-	10	15	10	-	-	-	10	10	5	-	-	-	5	10	15	-	-	-	-	5	5	-	-	-	-	5	5	-	-	-	20	20	25	-	-	-
Cephalosporium aspermum	-	-	-	25	30	50	-	-	-	30	30	25	-	-	-	30	30	25	-	-	-	25	20	20	-	-	-	30	25	25	-	-	-	30	20	25	-	-	-	30	30	35	-	-	-	40	50	55
Aspergillus fumigatus	50	35	30	40	30	20	55	45	40	45	45	40	40	55	60	45	40	40	50	45	40	50	45	45	55	55	60	45	40	40	50	40	30	50	50	40	50	45	40	50	55	40	60	65	50	55	70	75
A. flavus	40	35	35	35	40	45	45	50	50	35	30	30	40	30	30	35	35	30	35	30	30	35	30	30	35	30	30	30	25	25	40	30	30	30	30	25	35	30	30	35	30	30	55	45	40	35	45	50
A. niger	20	25	40	30	35	50	30	35	45	35	40	50	45	30	35	60	50	40	40	45	40	25	35	50	25	30	35	20	30	40	55	60	60	40	35	30	35	45	50	30	40	50	35	40	45	40	50	60
A. terreus	-	-	-	25	35	45	-	-	-	20	15	20	-	-	-	20	20	25	-	-	-	20	15	15	-	-	-	15	10	15	-	-	-	20	10	10	-	-	-	20	15	10	-	-	-	25	30	40
A. clavatus	20	15	15	20	30	40	15	30	30	20	20	20	20	25	25	20	20	25	20	20	25	15	15	20	15	10	5	15	10	10	15	10	10	15	10	10	25	25	30	10	10	5	20	30	30	25	35	45
A. sparsus	-	-	-	15	20	20	-	-	-	15	15	10	-	-	-	20	15	10	-	-	-	15	10	10	-	-	-	15	15	10	-	-	-	20	15	10	-	-	-	10	10	5	-	-	-	30	35	40
A. flavipes	25	20	20	-	-	-	15	15	15	-	-	-	20	15	15	-	-	-	15	10	10	-	-	-	15	15	10	-	-	-	15	20	20	-	-	-	10	10	15	-	-	-	30	35	40	-	-	-
Gliodadium roseum	20	25	30	25	30	40	15	20	20	25	30	30	20	15	15	25	35	35	20	15	15	25	35	35	10	10	15	10	15	20	15	15	25	20	25	35	30	25	20	10	15	10	25	25	35	30	40	45
Monosporium olivaceum	-	10	15	-	-	-	-	-	5	-	-	-	-	5	-	-	-	-	-	5	10	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	10	20	25	-	-	-
Cladosporium herbarum	30	35	45	20	25	35	35	30	45	20	20	25	30	30	40	20	15	10	5	30	40	20	15	15	15	20	20	25	20	15	30	30	25	20	15	10	30	25	0	25	20	20	35	40	45	45	35	40
Memnoniella echinata	-	-	20	25	30	40	-	-	-	20	20	15	-	-	-	20	15	10	-	-	-	25	25	20	-	-	-	20	15	15	-	-	-	15	10	20	-	-	-	-	-	-	-	-	30	30	35	45
Trichoderma viridae	25	20	15	25	30	40	25	25	30	20	15	15	20	20	25	25	25	20	15	10	15	20	20	15	15	10	10	20	15	15	25	30	30	25	20	20	25	5	30	20	25	30	30	25	25	30	35	45
Humicola fuscotra	-	-	-	-	15	20	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-	-	5	-	-	-	-	-	10	5	-	-	-	-	15	10	-	-	-	-	10	15	-	-	-	15	20	25
Fusarium oxysporum f.sp.*ciceri*	30	35	40	-	-	-	25	-	-	-	-	-	30	25	-	-	-	-	25	20	20	-	-	-	25	-	-	-	-	-	25	20	15	-	-	-	25	30	30	-	-	-	40	40	35	-	-	-
Alternaria alternata	10	15	20	-	-	-	-	10	5	-	-	-	10	10	5	-	-	-	5	10	10	-	-	-	10	15	10	-	-	-	10	10	10	-	-	-	10	10	10	-	-	-	20	30	45	-	-	-
A. humicola	-	-	-	-	10	20	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-	-	10	10	-	-	-	-	5	5	-	-	-	-	5	5	-	-	-	-	15	30
Drechslera hawaiensis	-	30	20	-	15	20	-	30	15	-	10	10	-	30		-	1	1	-	5	15	-	20	15	-	20	15	-	10	10	-	25	30	-	10	10	-	30	25	-	20	25	-	30	40	-	20	30
Curvularia lunata	-	30	40	-	20	30	-	10	15	-	15	15	-	10	20	-	10	15	-	30	30	-	20	25	-	15	20	-	15	15	-	20	20	-	20	25	-	5	5	-	15	10	20	35	45	15	25	35
Sclerotium folfsii	-	-	15	-	-	15	-	-	5	-	-	-	-	-	5	-	-	-	-	-	10	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	20	-	5	20
Sterile black mycelium	-	-	-	25	30	35	-	-	-	20	20	15	-	-	-	5	5		-	-	-	25	25	25	-	-	-	20	20	25	-	-	-	20	15	15	-	-	-	20	20	25	-	-	-	25	35	45
Sterile brown mycelium	25	30	35	-	-	-	25	20	25	-	-	-	20	15	1	-	-	-	5	0	20	-	-	-	25	30	20	-	-	-	20	30	40	-	-	-	5	5	15	-	-	-	35	40	45	-	-	-

*Number of spray

3.4 RHIZOSPHERE AND RHIZOPLANE MYCOFLORA OF CHICKPEA PLANTS CULTIVAR JG-62 AND JG-74 INOCULATED WITH FUSARIUM OXYSPORUM F.SP. CICERI IN RELATION TO SOIL AMENDMENT

Result presented in Table 21 and 23 reveal that soil amendment influenced the rhizosphere mycoflora both qualitatively and quantitatively. The rhizosphere mycoflora was also different in the two varieties tested. Further the inoculated of plants with Fusarium oxysporum f.sp. ciceri resulted in increase in the mycoflora. In amongst the two cultivars tested, the number of fungi was more in the rhizosphere of JG-62 both in inoculated and uninoculated although more fungi in inoculated rhizosphere. The number of fungi was also more in where oil cakes were used as amendments. The number of fungi in the rhizosphere of inoculated plants of JG-62 with urea was 29, with superphosphate 30, with muriate of potash 27 as against 26 in uninoculated plants; with castor cake 30, with neem cake 32, with mustard cake 34 as against 28 in uninoculated plants; with mahua cake 30 as against 27 in uninoculated plants; with bavistin 24, with vitavax 26, with brassicol 26, with benlate 25, with captan 26, with wettable sulphur 25 in inoculated as against 20, 21, 21, 20, 21 and 21 in uninoculated plants. The number of fungi in the rhizosphere of plants grown in unamended soil was 28 in inoculated as against 20 in uninoculated plants. Almost identical results were obtained with

JG-74 but less number of fungi. The number of fungi was more in the rhizosphere of plants grown in soil amended with fertilizers and oil cakes and less in those treated with fungicides.

As a result of treatment of soil with urea, superphosphate and muriate of potash, almost all the fungi isolated exhibited increased frequency in the rhizosphere of both inoculated and uninoculated plants of JG-62 with respect to control (Table 21) except Syncephalastrum racemosum, Botrytis cinerea, Chaetomium flavum, Aspergillus flavipes and Drechslera hawaiensis in inoculated and D. hawaiensis, Alternaria alternata, Fusarium moniliformae, F. oxysporum and Acrophialophora fusipora in uninoculated plants treated with muriate of potash. As a result of treatment with urea the frequency of Rhizopus oryzae increased highest in inoculated and that of Aspergillus fumigatus in uninoculated; with superphosphate Aspergillus niger in inoculated and A. fumigatus in uninoculated and with muriate of potash A. niger in inoculated and Memnoniella echinata and Trichoderma viridae in uninoculated plants.

Saprophytic fungi which exhibited higher frequency in uninoculated plants as compared to inoculated as a result of treatment with urea included A. fumigatus, A. flavus, A. sparsus, A. niger, A. oryzae; with superphosphate A. fumigatus, A. flavus, A. niger, A. sparsus and A. oryzae

and with muriate of potash A. flavus, A. sparsus and T. viridae. Fungi which were present in uninoculated rhizosphere as a result of treatment with urea, superphosphate and muriate of potash included A. fumigatus, A. luchuensis, A. terreus, T. allii, Humicola, A. fuscotra, M. echinata, T. viridae and sterile black mycelium. In addition to this F. moniliformae with urea and muriate of potash and F. oxysporum with muriate of potash.

With oil cakes not all fungi showed increase in frequency A. fumigatus exhibited highest frequency both in inoculated and uninoculated plants as a result of treatment with castor cake and neem cake; with mustard cake the frequency of A. fumigatus was highest in inoculated and that of A. flavus and sterile black mycleium in uninoculated plants and with mahua cake A. fumigatus in inoculated and A. fumigatus and A. niger in uninoculated plants.

Aspergillus funiculosus, A. luchuensis and sterile black mycelium were present only in the rhizosphere of uninoculated plants treated with castor cake, neem cake, mustard cake and mahua cake. In addition to this T. viridae was also isolated from the rhizosphere of uninoculated plants treated with castor cake F. oxysporum with neem cake and mahua cake and F. moniliformae with mahua cake.

As a result of treatment with fungicides the frequency of all the fungi boty saprophytic and parasitic decreased except. A. fumigatus in uninoculated plants treated with different fungicides and that of A. flavus in both inoculated and uninoculated plants treated with bavistin; R. oryzae in inoculated plants treated with bavistin, captan and wettable sulphur and Cladosporium herbarum in inoculated plants treated with bavistin and vitavax. Thus the fungicide had adverse effect on the soil mycoflora both of inoculated and uninoculated plants.

The frequency of pathogenic fungus F. oxysporum f.sp. ciceri with increases urea and superphosphate but muriate of potash, oil cakes and fungicides treatment indicated lower frequency. The frequency ranged from 55 to 85 in fertilizers treated plants and 0 to 25 in oil cakes and fungicides treated plants as against 65 in untreated inoculations. Similarly other pathogenic fungi i.e. Macrophomina phasiolina, A. alternata indicated increase in frequency with fertilizers and decreased with oil cakes and fungicidal treatments. The frequency of former ranged from 20 to 30 in fertilizers treatment and 5 to 15 in oil cake and fungicidal treatment as against 20 in control and that of later ranged from 50 to 30 in fertilizers and 5 to 20 in oil cake and fungicidal treatment as against 30 in control.

Thus oil cake treatment not only brought about decrease in the frequency of pathogenic forms but also increase in the saprophytic forms. Therefore, treatment with oil cakes is more benificial to the plant and for the disease control.

Almost a similar trend was obtained with JG-74 (Table-23) Cephalosporium aspermum, R. oryzae, Phoma hibernica, A. luchuensis, H. fuscotra, Alternaria humicola and sterile black mycelium were among those saprophytic fungi reported from rhizosphere of uninoculated plants treated with urea, superphosphate and muriate of potash. Frequency of Mucor globosus, A. flavus, A. niger, A. terreus, A. clavatus, Penicillium notatum, Gliocladium roseum, M. echinata was higher in uninoculated plants as compared to inoculated as a result of treatment with urea, superphosphate and muriate of potash Cunninghamella echinulata, A. fumigatus with urea and superphosphate and C. herbarum, D. hawaiensis and C. lunata with muriate of potash only.

C. aspermum, A. luchuensis, H. fuscotra and A. humicola were isolated from uninoculated plants treated with castor cake neem cake, mustard cake and mahua cake. In addition to this A. sparsus was isolated from the rhizosphere of inoculated plants treated with castor cake, neem cake and mustard cake.

As a result of treatment with fungicides, the frequency of all the fungi both saprophytic and parasitic decreased except A. fumigatus in inoculated and uninoculated plants

treated with different fungicides and A. terreus treated with bavistin, vitavax brassicol and benlate; Rhizopus nodosus in inoculated plants treated with bavistin and captan; Mucor globosus and A. flavus treated with bavistin and vitavax; A. niger treated with vitavax and wettable sulphur; A. clavatus treated with bavistin, vitavax, brassicol and wettable sulphur, T. viridae treated with bavistin brassicol and wettable sulphur and Trichoderma lignorum treated with bavistin, vitavax and captan. The remaining fungi exhibited reduction in frequency as control.

Addition of inorganic fertilizers in soil brought about increase in frequency of almost all the fungi isolated except R. nodosus, C. echinulata, A. alternata as a result of treatment with urea; R. nodosus, M. globosus and A. alternata with superphosphate C. echinulata, C. flavum, P. hibernica, C. lunata and A. alternata in inoculated plants treated with muriate of potash but in uninoculated plants the exception was A. sparsus and A. alternata in all the fertilizers.

Amongst the oil cakes, mustard cake favoured the increase in the frequency of largest number of fungi followed by neem cake, castor cake, and mahua cake in inoculated plants while in uninoculated there has not been a material change, R. nodosus, A. funigatus, A. flavus, A. nigar, A. terreus exhibited increase in fequency in all the oil cakes both in

inoculated and uninoculated plants; C. herbarum in uninoculated treated with castor, neem and mahua cake, A. lucheunsis in castor, neem and mustard cake whereas Torulla allii, H. fuscotra, G. roseum, P. notatum in all the oil cake treatments. There was increase in frequency in A. flavus in castor, neem and mustard, Penicillium notatum in castor, neem and mahua and G. roseum in castor and neem cake in inoculated plants.

Fungicidal treatment suppressed the frequency of almost all the fungi both saprophytic and parasitic except a few such as A. fumigatus and A. terreus in some fungicides.

There were some qualitative differences between mycoflora of two varieties, R. nodosus, A. clavatus, P. notatum, M. globosus, G. racemosum and T. lignorum were isolated from inoculated and uninoculated plants, A. terreus, M. echinata, Verticillium glaucum and T. viridae from inoculated and P. hibernica and A. humicola from uninoculated plants of JG-74 and not of JG-62 whereas Acrophialophora fusipora was isolated from both inoculated and uninoculated plants, Mucor racemosus, R. oryzae, Syncephalastrum racemosum, R. oryzae, Syncephalastrum racemosum, M. phasiolina, B. cineria from inoculated and F. oxysporum, F. moniliformae and A. alternata from uninoculated and not from the other cultivar.

A similar trend was observed with rhizoplane fungi with more number of fungi in those inoculated with *F. oxysporum* f.sp. *ciceri* (Table 22 and 24). In amongst the two cultivars tested, number of fungi was more in the rhizoplane of cv.JG-62 both in inoculated and uninoculated plants; with urea it was 22 with superphosphate 23 with muriate of potash 21, with castor cake 23, with neem cake 23, with mustard cake 22 with mahua cake 20, with bavistin 16, with brassicol 20, with vitavax 21 with captan 21 against 18 to 21 in uninoculated ones. With benlate and wettable sulphur there has been no difference in the number of fungi in inoculated and uninoculated rhizoplane. In the wettable sulphur the number of fungi was 19 while in benlate was 17, the number of fungi in the rhizoplane of unamended control plants was 21 in inoculated as against 20 in uninoculated plants. With JG-74, the number of fungi was relatively less as compared with JG-62 however fertilizers and oil cakes treatments supported the number of fungi where it was 21 to 24 in inoculated as against 18 to 20 in uninoculated plants. In fungicidal treatment it ranged from 16 to 19 in inoculated as against 17 to 18 in uninoculated plants. The number of fungi control plants was 20 in inoculated as against 18 in uninoculated plants.

Treatment with urea, superphosphate and muriate of potash brought about increase in frequency of almost all the fungi isolated from rhizoplane of JG-62 with respect to control

(Table 22) except C. lunata in uninoculated plants treated with urea; B. cinerea in inoculated plants with superphosphate and C. lunata and A. alternata in both inoculated and uninoculated plants. A. fusipora, R. solani, S. rolfsii, F. oxysporum f.sp. ciceri in inoculated and F. oxysporum, D. hawaiensis in uninoculated plants with muriate of potash. As a result of treatment with urea the frequency of M. olivacium was highest in inoculated and that of A. fumigatus in uninoculated plants, with superphosphate R. oryzae in inoculated and A. fumigatus in uninoculated plants.

The frequency of R. oryzae, C. flavum, A. fumigatus, A. flavus, A. niger, A. sparsus was highest in uninoculated as against inoculated plants when treated with urea, superphosphate and muriate of potash. Fungi which are present only in the rhizoplane of uninoculated plants as a result of treatment with urea, superphosphate and muriate of potash included A. terreus, A. lucheunsis, M. echinata, H. fuscotra, T. viridae and sterile black mycelium. In addition to this C. aspermum with urea and muriate of potash.

Not all the fungi exhibited increased frequency as a result of oil cake treatment the sterile brown mycelium exhibited highest increase in inoculated and A. fumigatus in uninoculated plants. As a result of treatment with castor cake A. niger in inoculated and A. fumigatus in uninoculated

plants, with neem, mustard and mahua cake C. aspermum, A.terreus, A. luchuensis, M. echinata and H. fuscotra were present only in the rhizoplane of uninoculated plants treated with castor, neem, mustard and mahua cake. In addition to this F. oxysporum was also isolated from rhizoplane of uninoculated plants treated with mustard and mahua cake and T. viridae with mahua cake.

Due to treatment with fungicides, the frequency of all the fungi both saprophytic and parasitic decreased except A. fumigatus in inoculated and uninoculated plants treated with different fungicides and that of A. flavus in inoculated plants treated with bavistin, vitavax and benlate, A. niger with bavistin, vitavax and brassicol, R. oryzae and M.racemosus with vitavax and brassicol and C. echinulata with vitavax only.

The frequency of pathogenic fungus F. oxysporum f.sp. ciceri considerably increased with fertilizers except muriate of potash but oil cakes and fungicides treatment indicated lower frequency. The frequency ranged from 70 to 85 in fertilizers treated plants and 0 to 25 in oil cakes and fungicides treated plants as against 60 in untreated inoculation. Similarly, other pathogenic fungi i.e. A. alternata indicated increase in frequency with fertilizers and decreased with oil cake and fungicidal treatments. The frequency ranged from 40 to 50 in urea and superphosphate and 5 to 20 in muriate

of potash, oil cakes and fungicidal treatment as against 30 in control.

C. aspermum, H. fuscotra and A. humicola among those saprophytic fungi reported from rhizoplane of uninoculated plants of JG-74 treated with urea, superphosphate and muriate of potash. In addition to this R. oryzae, A. sparsus from rhizoplane of uninoculated plants treated with urea and superphosphate. Frequency of A. flavus, A. niger, A. terreus, A. clavatus, M. echinata and T. viridae was higher in uninoculated plants as compared to inoculated as a result of treatment with urea, superphosphate and muriate of potash, A. fumigatus with urea and superphosphate and C. herbarum with urea. C. aspermum, A. humicola were isolated from uninoculated plants treated with castor cake, neem cake, mustard cake and mahua cake. As a result of treatment with fungicides the frequency of all the fungi both saprophytic and parasitic decreased except A. fumigatus in inoculated and uninoculated plants treated with different fungicides. R. nodosus in inoculated plants with bavistin, vitavax and captan;: M. globosus with vavistin and vitavax; A. flavus with with bavistin; A. niger with bavistin, brassicol, captan and wettable sulphur; A. clavatus with bavistin, vitavax, brassicol, benlate and wettable sulphur and T. viridae with bavistin, vitavax, brassicol and wettable sulphure. All the remaining fungi exhibited reduction in frequency as compared

to control. A similar trend was observed in the reduction in the frequency of pathogenic fungi.

The two cultivars also exhibited differences in rhizoplane. M. globosus, G. roseum and A. humicola were isolated from JG-74 while A. luchuensis, B. cinerea, A. fusipora and F. oxysporum from JG-62.

It is interesting to note that the frequency of saprophytic fungi such as Aspergillus species was more in the rhizoplane of JG-74 both in inoculated and uninoculated plants as a result of treatment with different fertilizers, oil cakes and fungicides, On the other hand, the frequency of pathogenic fungi was more in the rhizoplane of JG-62 due to various treatments. It is likely that higher frequency of saprophytic fungi in JG-74 is a contributory factor towards less development of disease on JG-74.

FIG. 5. Population of fungi in the non-rhizosphere, rhizosphere of uninoculated and inoculated plants of chickpea cultivar JG-62(with *Fusarium oxysporum* f.sp. *ciceri*) treated with different soil amendments.

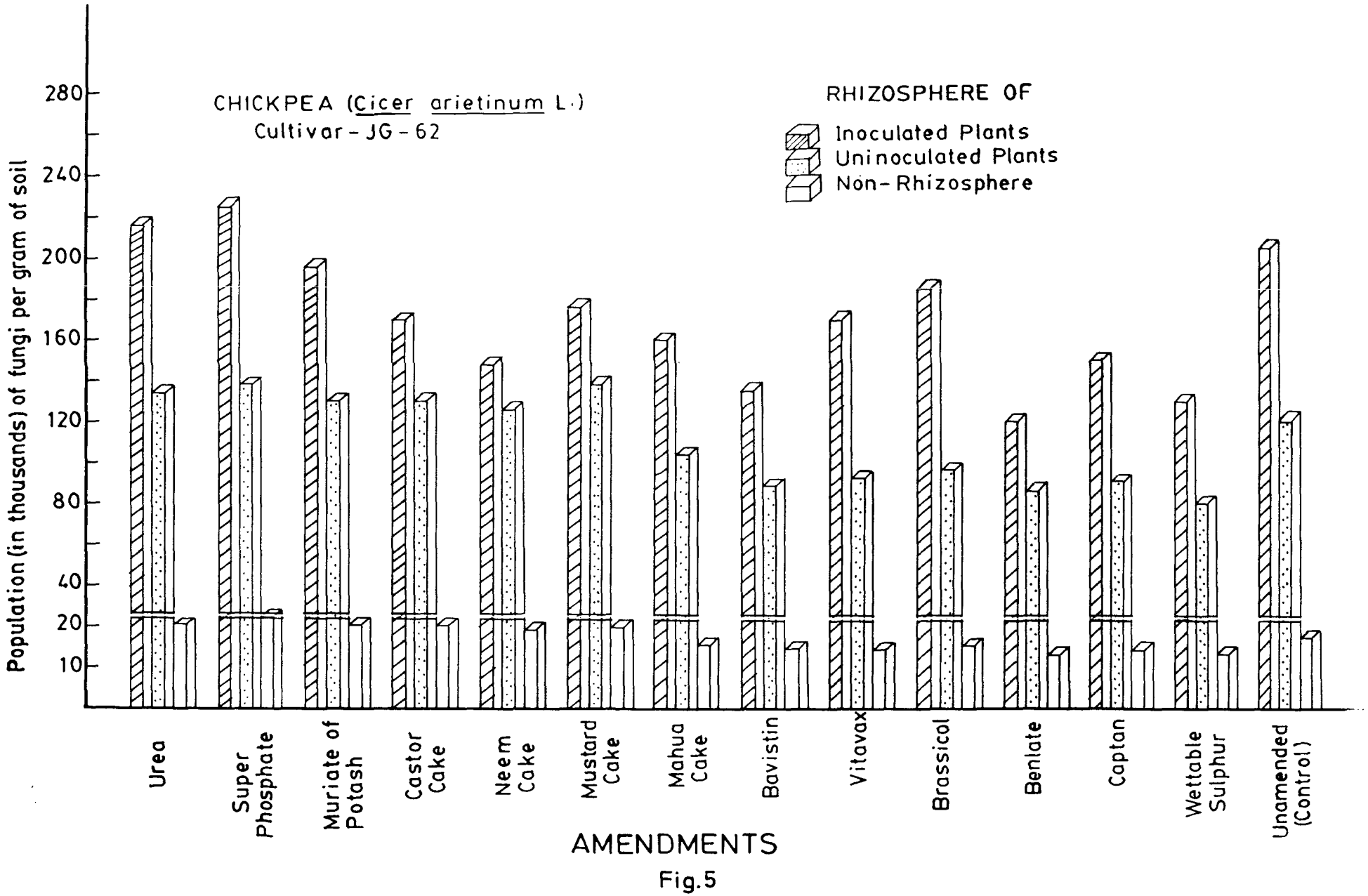
CHICKPEA (Cicer arietinum L.)
Cultivar - JG - 62
RHIZOSPHERE OF
Inoculated Plants
Uninoculated Plants
Non-Rhizosphere
Population (in thousands) of fungi per gram of soil
280
240
200
160
120
80
40
20
10
Urea
Super Phosphate
Muriate of Potash
Castor Cake
Neem Cake
Mustard Cake
Mahua Cake
Bavistin
Vitavax
Brassicol
Benlate
Captan
Wettable Sulphur
Unamended (Control)
AMENDMENTS

Fig.5

FIG. 6. Population of fungi in the non-rhizosphere, rhizosphere of uninoculated and inoculated plants of chickpea cultivar JG-74 (with Fusarium oxysporum f.sp. ciceri) treated with different soil amendments.

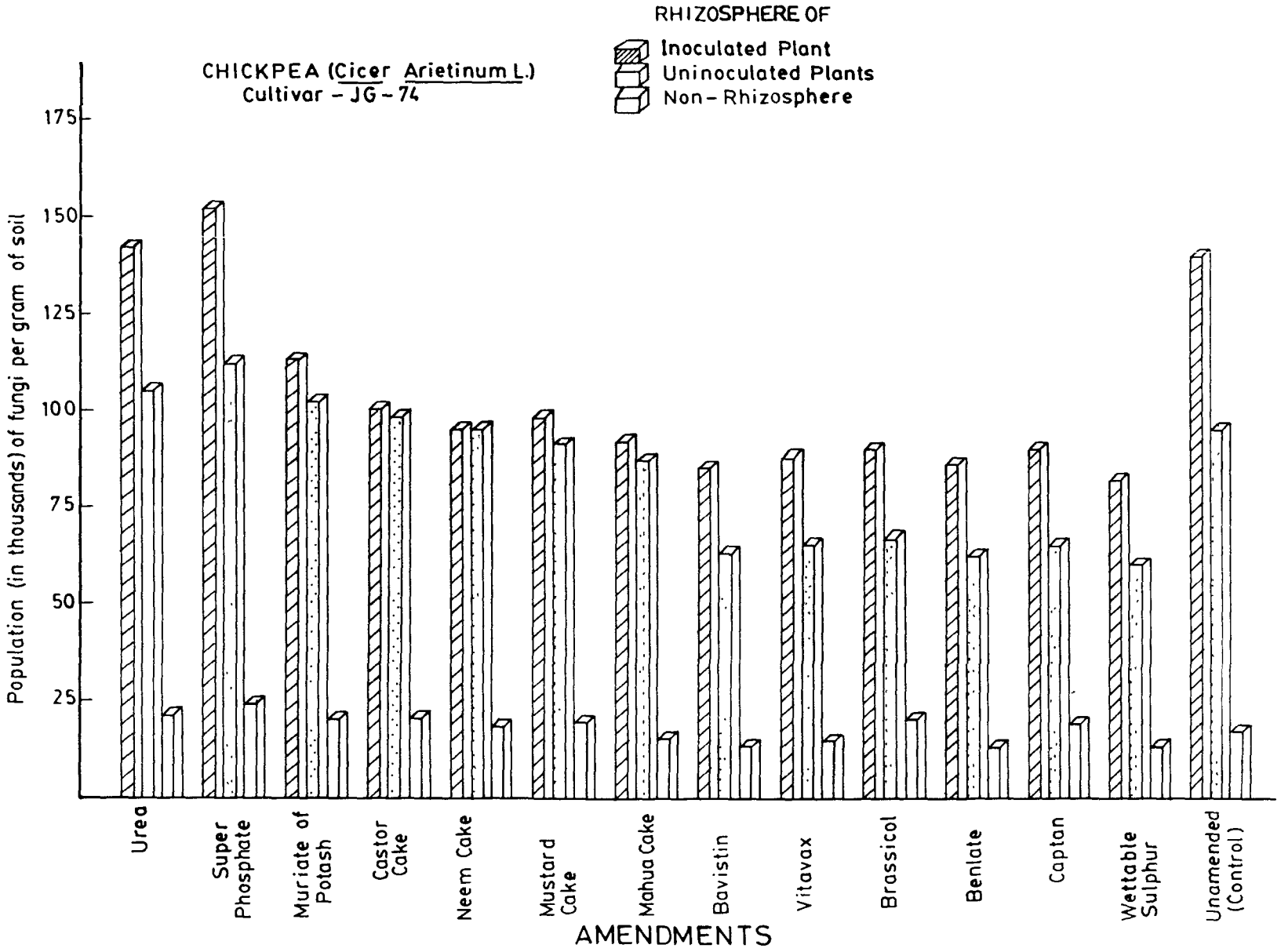
CHICKPEA (Cicer Arietinum L.)
Cultivar – JG – 74
RHIZOSPHERE OF
Inoculated Plant
Uninoculated Plants
Non – Rhizosphere
Population (in thousands) of fungi per gram of soil
175
150
125
100
75
50
25
Urea
Super Phosphate
Muriate of Potash
Castor Cake
Neem Cake
Mustard Cake
Mahua Cake
Bavistin
Vitavax
Brassicol
Benlate
Captan
Wettable Sulphur
Unamended (Control)
AMENDMENTS

Fig. 6

TABLE - 20: Population of fungi (per gram of soil) in the non-rhizosphere and rhizosphere of chickpea plants (cultivar JG-62 and JG-74) uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri under different soil amendments

Amendments	Non-rhizosphere	RHIZOSPHERE							
		JG-62				JG-74			
		Inoculated Plant	R:S Ratio	Uninoculated Plant	R:S Ratio	Inoculated Plant	R:S Ratio	Uninoculated Plant	R:S Ratio
Control	17.0	205.0	12.05	120.0	7.05	140.0	8.23	95.0	5.59
Urea	21.5	216.5	10.06	134.0	6.23	146.0	6.79	105.0	4.88
Superphosphate	24.0	225.0	9.37	138.5	5.77	142.0	5.91	112.0	4.66
Muriate of Potash	20.5	195.0	9.51	131.5	6.41	113.0	5.50	102.0	4.97
Castor Cake	20.0	170.0	8.50	129.0	6.45	100.0	5.00	98.0	4.90
Neem Cake	18.5	148.0	8.00	126.0	6.81	95.0	5.13	95.0	5.13
Mustard Cake	19.0	176.0	9.26	128.5	6.76	98.0	5.15	96.5	5.07
Mahua Cake	14.5	160.0	11.03	104.5	7.17	92.5	6.37	87.0	6.00
Bavisting	13.5	135.0	10.00	88.5	6.55	85.5	6.33	63.5	4.70
Vitavax	14.0	170.0	12.14	92.0	6.57	87.5	6.25	65.5	4.67
Brassicol	15.0	185.0	12.33	95.5	6.36	90.0	6.00	66.5	4.43
Benlate	13.0	120.0	9.23	85.0	6.53	86.0	6.60	62.0	4.76
Captan	14.0	150.0	10.71	90.0	6.42	90.0	6.42	65.0	4.64
Wettable Sulphur	12.5	130.0	10.40	80.0	6.40	82.0	6.56	60.0	4.80
L.S.D. at 5%	1.3367147	0.955214		1.2423029		1.0873148		1.10338	
L.S.D. at 1%	1.816875	1.2983358		1.6885497		1.477883		1.4997243	

TABLE - 21: Frequency (percentage) of fungi in the rhizosphere of chickpea plants cult var I - 2 inoculated and inoculated with Fusarium oxysporum f.sp. ciceri under different soil amendments

Fungi isolated	1		2		3		4		5		6		7		8		9		10		11		12		13		14	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Rhizopus oryzae	15	30	35	40	30	45	25	35	30	35	25	35	20	30	30	25	20	15	15	20	15	15	10	15	20	25	10	20
Mucor racemosus	10	-	20	-	25	-	15	-	5	5	10	5	10	10	5	5	5	-	10	-	15	-	5	-	5	-	20	-
Cunninghamella echinulata	20	-	25	-	30	-	25	-	10	10	10	5	15	10	15	15	15	-	25	-	20	-	5	-	15	-	10	-
Mortierilla alpina	15	-	25	-	35	-	20	-	15	-	10	-	10	-	10	5	5	-	5	-	5	-	5	-	10	-	5	-
Cephalosporium aspermum	20	15	30	25	35	30	25	20	10	10	10	10	15	10	10	5	10	-	5	-	10	-	5	-	15	-	10	-
Monilia humicola	30	25	50	40	45	40	40	35	30	30	30	25	30	25	15	10	15	15	20	10	20	15	15	10	20	15	15	10
Syncephalastrum racemosum	20	-	40	-	35	-	15	-	20	-	15	-	15	-	15	-	10	-	15	-	10	-	10	-	10	-	10	-
Chaetomium flavum	15	20	40	30	50	35	25	25	15	20	20	20	15	10	20	15	15	10	10	10	20	15	10	10	15	10	10	10
Macrophomina phaseolina	20	-	30	-	20	-	25	-	15	-	5	-	10	-	-	-	-	-	5	-	5	-	5	-	10	-	10	-
Aspergillus fumigatus	35	25	50	70	55	70	65	45	55	75	50	80	40	40	50	45	35	40	35	45	40	30	30	35	25	35	20	25
A. flavus	20	25	40	50	50	55	35	45	30	45	30	40	25	50	30	40	30	30	40	15	15	20	20	15	10	20	10	15
A. niger	15	30	30	40	40	45	30	35	20	50	25	45	20	40	30	45	20	20	15	25	15	25	10	15	25	25	20	15
A. funiculosus	-	20	-	25	-	30	-	25	-	25	-	25	-	20	-	20	-	15	-	10	-	10	-	10	-	15	-	10
A. terreus	-	20	-	40	-	45	-	35	10	40	20	35	15	30	15	35	-	15	-	10	-	15	-	10	-	10	-	10
A. luchuensis	-	10	-	15	-	20	-	15	-	25	-	25	-	20	-	25	-	-	-	-	-	-	-	-	-	-	-	5
A. sparsus	15	20	25	35	30	35	20	35	25	30	20	30	25	35	20	25	10	10	10	15	10	10	10	10	5	10	5	15
A. candidus	15	-	25	-	30	-	20	-	15	-	20	-	20	-	20	-	10	-	10	-	10	-	5	-	10	-	5	-
A. flavipes	20	15	30	25	35	30	20	20	30	20	25	20	20	20	30	25	10	-	5	-	5	-	5	-	10	10	5	-
Monosporium olivaceum	1	-	5	-		-	20	-	10	-	1	-	5	-	10	-		-	5	-	5	-	5	-	5	-	10	-
Botrytis cinerea	20	-	40	-		-	15	-	-	-	10	-	5	-	5	-	10	-	15	-	15	-	10	-	10	-	10	-
Torulla allii	-	0	-	5	-	10	-	35	10	25	15	35	10	30	10	25	-	10	-	15	-	15	-	10	-	15	-	10
Humicola fuscotra	-	25	-	5	-	10	-	30	10	35		30	15	35	5	15	-	15	-	20	-	15	-	15	-	20	-	15
Memnoniella echinata	-	25	-	10	-	15	-	50	20	35	15	40	15	35	10	10	-	10	-	10	-	10	-	10	-	15	-	15
Cladosporium herbarum	30	25				10	15	35	25	0	0	20	20	15	20	25	35	20	40	20	20	15	15	20	20	20	15	10
Drechslera halodensis	25	20	15		0	35	25	20	0	0	15	15	15	15	15	10	15	15	10	15	20	15	15	15	15	10	15	5
Curvularia lunata	25	20	35	0	10	35	30	25	15	15	20	15	20	20	15	15	10	15	15	10	10	15	10	10	10	10	5	10
Alternaria alternata	30	20	30	35	0	40	30	15	5	10	10	5	15	10	10	10	5	10	15	15	15	15	15	10	20	15	15	
Fusarium moniliformae	-	20	-		5	30	-	20	20	25	5	25	10	25	-	30	-	10	-	10	-	10	-	15	-	10	-	15
F. oxysporum	-	30	10	30	0	25	-	20	5	35	-	20	-	25	10	35	-	20	-	10	-	10	-	10	-	20	-	15
F. oxysporum f.sp. ciceri	65	-	70	-	65	-	55	-	15	-	-	-	25	-	-	-	-	-	15	-	20	-	-	-	20	-	10	-
Trichosporium fuscum	20	10	30	20	35	20	25	15	15	5	20	10	25	15	10	-	5	-	5	-	10	-	-	-	5	-	-	-
Spicaria silvatica	25	15	35	25	40	25	30	20	10	10	15	15	30	20	5	-	10	-	10	-	15	-	5	-	-	-	-	-
Trichoderma viridae	-	20	-	35	-	45	20	40	-	20	10	15	10	20	5	15	-	15	-	10	-	20	-	15	-	10	-	10
Acrophalophora fusispora	15	10	30	20	35	20	20	10	-	5	10	5	5	10	10	5	5	-	15	5	5	5	5	-	5	-	-	-
Sclerotium rolfsii	10	-	20	-	15	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Rhizoctonia solani	15	-	20	-	10	-	-	-	-	-	5	-	5	-	-	-	-	-	-	-	-	-	5	-	5	-	5	-
Sterile brown mycelium	25	-	40	-	45	-	35	-	35	-	35	-	45	-	30	-	10	-	5	-	15	-	15	-	25	-	15	-
Sterile black mycelium	-	30	-	55	-	50	-	45	-	40	-	40	-	50	-	40	-	15	-	15	-	20	20	20	-	20	-	15

1. Control, 2. Urea, 3. Superphosphate, 4. Muriate of potash, 5. Castor cake, 6. Neem cake, 7. Mustard cake,
8. Mahua cake, 9. Bavistin, 10. Vitavax, 11. Brassicol, 12. Benlate, 13. Captan, 14. Wettable sulphur
IP = Inoculated plants, UP = Uninoculated plants

: Frequency (percentage) of fungi in the rhizoplane of chickpea ... 3-62 uninoculated and inoculated with Fusarium oxysporum f.sp. ciceri ... different soil amendments

	1		2		3		4		5		6		8		9		10		11		12		13		14	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Chaetomium oryzae	15	25	25	35	35	40	25	35	20	25	30	35	25	35	15	15	25	20	20	15	10	10	20	25	10	15
Cunninghamella echinulata	20	-	25	-	30	-	25	-	15	-	15	-	10	10	5	5	15	-	25	-	20	-	10	-	15	-
Mucor racemosus	15	-	30	-	25	-	20	-	10	-	10	-	10	-	5	-	15	-	20	-	20	-	5	-	10	-
Chaetomium flavum	10	20	0	25	20	25	20	25	5	15	10	15	5	15	5	10	-	5	5	10	5	10	-	5	5	15
Mortierella alpina	10	-	15	-	20	-	20	-	5	-	10	-	5	-	5	-	5	-	5	-	-	-	5	-	-	-
Cephalosporium aspermum	-	20	-	30	10	35	-	25	-	15	-	10	-	5	-	10	-	5	-	15	-	10	-	5	-	15
Aspergillus fumigatus	30	20	40	60	40	65	40	45	40	60	40	60	45	60	40	70	35	25	40	40	35	35	25	30	25	40
A. flavus	25	40	40	65	40	70	40	55	35	45	35	50	45	45	30	55	30	20	35	25	25	30	30	20	20	30
A. niger	15	25	30	35	30	40	30	40	25	40	35	40	30	35	25	35	25	15	20	15	20	15	15	10	20	20
A. terreus	-	15	-	30	-	30	-	25	-	30	10	30	-	30	-	25	-	10	-	10	-	10	-	-	-	15
A. luchuensis	-	20	-	25	-	40	-	25	-	35	-	25	-	20	-	15	-	10	-	5	-	10	-	-	-	15
A. sparsus	25	30	30	40	40	50	40	35	40	30	50	55	40	35	30	35	10	10	15	20	15	15	10	15	15	20
A. flavipes	20	10	25	20	30	20	30	20	35	15	35	25	25	20	30	20	-	-	10	-	10	5	5	5	15	5
Botrytis cinerea	15	-	20	-	15	-	25	-	10	-	10	-	10	-	5	-	5	-	10	-	15	-	5	-	10	-
Cephalosporium olivaceum	20	-	45	-	40	-	40	-	10	-	5	-	5	-	5	-	-	-	5	-	5	-	-	-	5	-
Cunninghamella echinata	-	30	-	40	-	45	-	50	-	45	-	40	-	35	-	40	-	10	-	20	-	25	-	15	-	15
Humicola fuscotra	-	25	-	30	-	35	-	30	-	30	-	40	-	35	-	40	-	10	-	15	-	20	-	10	-	15
Fusarium oxysporum	-	10	15	15	20	20	-	5	15	15	10	15	-	15	-	20	-	-	-	5	-	20	-	5	-	10	-	15
F. oxysporum f.sp. ciceri	60	-	70	-	85	-	50	-	15	-	-	-	20	-	-	-	-	-	25	-	-	-	5	-	10	-	10	-
Alternaria alternata	30	20	45	45	45	50	20	10	15	20	10	15	20	15	10	10	15	10	20	10	15	15	10	10	15	10	10	5
Drechslera hawaiensis	20	15	25	20	40	25	25	15	15	10	15	10	20	10	20	10	10	-	15	15	15	10	10	10	20	15	15	10
Curvularia lunata	30	20	35	20	40	25	30	20	15	15	20	15	20	15	15	15	10	10	10	10	15	15	20	15	20	20	15	15
Cladosporium herbarum	25	20	40	30	45	30	30	25	20	25	25	20	20	20	15	15	25	10	25	15	20	15	20	15	20	5	15	5
Trichoderma viridae	-	25	-	40	-	40	-	45	10	20	5	15	10	15	-	10	-	10	-	20	1	25	-	20	-	15	-	15
Acremoniophora fusipora	25	15	40	25	45	40	10	20	20	10	10	10	15	15	5	5	10	15	15	10	10	10	10	-	20	10	15	5
Rhizoctonia solani	15	-	20	-	15	-	10	-	10	-	5	-	5	-	5	-	-	5	15	-	5	-	-	-	10	-	5	-
Sclerotium rolfsii	10	-	25	-	15	-	5	-	5	-	5	-	5	-	5	-	5	-	10	-	-	-	5	-	5	-	-	-
Sterile brown mycelium	30	-	45	-	40	-	35	-	45	-	40	-	35	-	35	-	15	-	20	-	25	-	15	-	20	-	5	-
Sterile black mycelium	-	30	-	40	-	45	-	35	-	35	-	35	-	40	-	35	-	15	-	20	-	20	-	15	-	10	-	25

... Control, 2. Urea, 3. Superphosphate, 4. Muriate of potash, 5. Castor cake, 6. Neem cake, 7. Mustard cake, 8. Mahua cake, 9. Bavistan, 10. Vitavax, ... Benlate, 13. Captan, 14. Wettable sulphur

... ted plants, UP = Uninoculated plants

TABLE - 23: Frequency (percentage) of fungi in the rhizosphere of chickpea plants cultivar JG-74 uninoculated and inoculated with Fusarium oxysporum f.sp.ciceri under different soil amendments

Fungi isolated	1		2		3		4		5		6		7		8		9		10		11		12		13		14	
	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP	IP	UP
Rhizopus oryzae	-	25	-	35	-	40	-	30	10	30	20	25	10	30	20	40	-	10	-	20	-	20	-	15	-	20	-	15
A. nodosus	20	15	15	20	15	25	30	20	35	30	30	20	25	15	20	20	20	5	15	10	15	15	10	10	25	15	10	15
Cunninghamella echinulata	25	-	20	-	20	-	25	-	15	10	10	-	10	-	15	-	10	-	15	-	20	-	10	-	15	-	15	-
Mucor lobosus	15	10	20	20	10	20	10	15	5	5	10	5	5	5	10	10	15	-	20	-	10	-	5	-	10	5	5	-
Absidia albira	10	-	15	-	20	-	15	-	10	-	5	-	5	-	5	-	-	-	10	-	5	-	-	-	-	-	-	-
Absidia humicola	20	20	30	25	35	25	25	25	10	15	10	10	5	10	15	15	10	10	15	15	10	15	10	10	15	15	10	10
Choanephora aspermum	-	30	-	35	-	40	-	35	-	20	-	10	-	10	-	15	-	15	-	25	-	20	-	10	-	20	-	20
Cladosporium flavum	20	-	30	-	30	-	15	-	15	-	20	-	10	-	15	-	-	-	15	-	10	-	10	-	10	-	10	-
Phoma fibernica	-	15	-	30	-	25	10	30	5	30	15	30	10	15	5	20	-	10	-	15	-	10	-	5	-	10	-	10
Aspergillus fumigatus	30	25	60	80	55	75	70	40	60	85	45	60	55	70	60	75	35	30	35	45	30	40	30	[illegible]	[illegible]	15	20	[illegible]
A. flavus	15	25	25	35	30	35	20	30	20	40	25	45	20	35	30	40	20	15	15	20	10	15	10	1	10	[illegible]	10	20
A. niger	20	35	55	65	60	70	65	75	65	65	70	70	40	45	50	60	20	20	25	30	20	30	15	[illegible]	[illegible]	20	25	25
A. flavipes	25	-	30	-	35	-	30	-	30	20	30	-	35	-	25	-	5	-	15	-	20	-	10	-	20	-	15	-
A. terreus	20	35	50	70	45	65	55	75	60	80	55	75	45	70	40	65	20	40	30	40	25	45	20	10	15	25	15	25
A. ochraceus	-	20	-	25	-	30	15	30	-	25	-	25	-	25	-	20	-	10	-	5	-	15	-	10	-	15	-	10
A. candidus	15	-	20	-	20	-	15	-	-	-	25	-	15	-	20	-	5	-	15	-	10	-	[illegible]	-	[illegible]	-	[illegible]	-
A. clavatus	10	25	20	40	20	50	25	45	10	40	15	50	15	40	10	40	15	15	15	20	20	15	5	10	10	20	15	20
A. sparsus	-	15	-	20	-	25	-	20	-	25	-	25	-	25	10	30	-	15	-	10	-	10	-	10	-	10	-	5
Penicillium notatum	20	35	35	40	30	45	25	40	30	45	30	40	20	45	25	40	10	15	15	30	10	25	10	20	20	30	15	25
Gliocladium roseum	30	40	40	50	35	55	35	45	45	50	35	50	25	60	30	50	10	20	20	30	15	25	15	25	25	35	20	30
Monosporium olivaceum	20	-	25	-	25	-	25	-	15	-	10	-	5	-	10	-	-	-	5	-	10	-	10	-	10	-	10	-
Torulla allii	-	25	-	35	-	40	-	30	15	30	10	35	-	40	-	35	-	10	-	20	-	15	-	15	-	20	-	15
Verticillium glaucum	25	-	30	-	35	-	30	-	35	-	30	-	35	-	35	-	15	-	20	-	20	-	10	-	20	-	25	-
Humicola fuscotra	-	20	-	25	-	30	-	30	-	30	-	35	-	30	-	35	-	10	-	15	-	15	-	15	-	10	-	10
Memnoniella echinata	15	35	30	65	35	55	30	70	15	45	20	40	15	45	20	40	10	30	10	20	15	20	10	25	15	25	10	25
Cladosporium herbarum	35	30	45	40	45	45	15	40	30	15	25	20	20	15	20	20	25	10	20	25	25	20	15	10	25	20	20	15
Drechslera hawaiensis	35	30	40	35	55	60	25	35	20	20	30	25	30	25	25	20	15	10	15	15	15	15	15	10	30	25	25	10
Curvularia lunata	40	35	60	50	50	55	20	40	20	20	30	20	25	20	20	20	20	20	25	20	25	20	20	15	30	25	20	20
Alternaria alternata	20	-	20	-	25	-	10	-	15	-	10	-	5	-	10	-	15	-	10	-	10	-	5	-	10	-	10	-
A. humicola	-	15	-	20	-	25	-	20	-	15	-	20	-	20	-	25	-	-	-	-	-	5	-	-	-	10	-	5
Fusarium oxysporum f.sp.ciceri	40	4-	45	-	50	-	40	-	-	-	5	-	20	-	-	-	-	-	20	-	15	-	-	-	25	-	20	-
Trichoderma viridae	10	30	20	35	15	45	25	40	15	40	20	40	15	40	10	25	15	15	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	30	15	15
T. lignorum	10	15	15	25	15	25	25	25	15	25	20	25	20	30	15	30	10	15	[illegible]	15	[illegible]	10	[illegible]	[illegible]	10	5	5	5
Sclerotium rolfsii	10	-	15	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sterile brown mycelium	25	-	40	-	35	-	40	-	35	-	40	-	50	-	40	-	15	-	-	-	[illegible]	-	[illegible]	-	25	-	20	-
Sterile black mycelium	-	20	-	30	-	40	-	45	-	35	-	40	-	45	-	45	-	1	-	1	-	[illegible]	-	[illegible]	-	10	-	-

1 Control, 2. Urea, 3. Superphosphate, 4. Muriate of potash, 5. Castor cake, 6. Neem cake, 7. Mustard cake, 8. [illegible] cake, 9. Bavistin, 10. Vitavax, 11. Bragsicol, 12. Benlate, 13. Captan, 14. Wettable sulphur; IP = Inoculated plants, UP = Uninoculated plants.

IP - Inoculated plants, UP = Uninoculated plants.

. frequency ... the rhizoplane of chic ... Flavor Fg-74 ... inoculated ... ... cicer...

...ated	1		2	UP	IP	P	4 IP	UP	5		6	P	8		9		10								14	P
...iz ...s oryzae	-		-	5	-	5	15		1				10	25	10	30	-	1	-	1	-	-	-		-	15	-	10
... nolosus	1		20	15	30	20	25	15	30		5	15	25	25		15		-	15		1	5		-		1		5
Cunninghamella echinulata	20	-	30	-	40	-	15	-	15	-	5		10	-		-		-	1	-		-	1	-	1	-	1	-
Mucor globosus	15	-	20	-	25	-	10	-	10	10	10	-	5	-	5	-		-	20	-	10	-		-		-	1	-
Mortierella alpina	10	-	15	-	20	-	5	-	5	-	-	-	5	-	5	-	-	-	5	-	5	-	-	-		-	-	-
Cephalosporium aspermum	-	25	-	35	-	50	-	35	-	20	-	10	-	15	-	15	-	15	-	10	-	10	-	10	-	20	-	15
Aspergillus fumigatus	35	30	60	75	60	85	80	40	55	70	60	80	60	65	70	90	40	55	30	40	30	5	15	5		40	5	35
A. flavus	30	5	30	60	50	70	50	75	45	30	-	65	50	55	50	30	55	50	25	5	25	5	20	5		30	0	25
A. niger	45	35	55	65	40	60	45	65	50	70	40	70	55	65	40	60	40	5	20	25	25	30	20	5	0	25	35	20
A. terreus	-	25	20	45	25	50	30	55	15	30	5	70	25	40	25	65	-	25	-	20	-	25	-	5	-	5	-	20
A. clavatus	20	30	40	55	45	65	40	50	35	5	30	55	30	50	40	55	20	20	25	25	30	5	5	25	15		40	25
A. sparsus	-	20	-	25	-	30	15	35	10	30	10	25	5	30	10	20	-	10	-	15	-	5	-	10	-		-	10
A. flavipes	5	-	30	-	25	-	20	-	1	-	5	-	25	-	10	-	1	-	10	-	10	-		-	5	-	10	-
Chaetomium roseum	30	45	45	60	60	65	50	65	35		35	30	40	50	45				25		15		0	30		5	20	25
Humicola fuscotra	-	15	-	30	-	30	-	30	10	30	15	30	10	25	5	10	-	10	-	10	-		-	5	-	10	-	0
Memoniella echinata	-	25	25	45	15	50	20	50	10	40	15	35	15	30	10	20	-	15	-		-	5	-	10	-	20	-	15
Drechslera hawaiensis	25	15	30	20	55	35	30	30	20	10	25	15	20	10	20	15	15	10	15		10	10	10	15	5	10	15	5
Curvularia lunata	40	30	45	35	40	40	40	40	30	15	30	15	25	20	30	10	25	20	30	5	25		5		25	25	25	15
Cladosporium herbarum	30	20	35	45	35	30	35	35	20	10	20	15	25	15	20	10	5	10	20	5	25	5	20		20	5	20	15
...ternaria alternata	20	-	35	-	40	-	10	-	10	-	5	-	15	-	-	-	5	-	15	-	10	-	10	-	10	-	10	-
A. humicola	-	15	-	25	-	25	-	30	-	20	-	25	-	10	-	10	-	5	-	10	-	5	-	10	-	5	-	-
Fusarium oxysporum f.sp.ciceri	40	-	40	-	45	-	30	-	-	-	-	-	15	-	-	-	-	-	20	-	15	-	-	-	-	-	5	-
Trichoderma viridae	10	25	25	40	25	45	20	40	20	40	15	40	20	30	25	30	15	15	15	15	15	10	5	5	10	20	25	20
Rhizoctonia solani	20	-	25	-	20	-	15	-	5	-	10	-	10	-	5	-	5	-	10	-	10	-	5	-	15	-	10	-
Sclerotium rolfsii	15	-	20	-	25	-	10	-	-	-	-	-	5	-	-	-	-	-	5	-	5	-		-	10	-	5	-
Sterile balck mycelium	-	30	-	40	-	45	-	40	-	35	-	40	-	30	-	25	-	20	-	25	-	0	-	15	-		-	25
Sterile brown mycelium	25	-	35	-	40	-	30	-	35	-	35	-	30	-	20	-	15	-	20	-	20	-	1	-	15	-	20	-

. Control, 2. Urea, 3. Superphosphate, 4. Muriate of potash, 5. Castor cake, 6. Neem cake, 7. Mustard cake, 8. Mahua cake, 9. ..., 10. ...ex,
. Bavistin, 12. Benlate, 13. Captan, 14. Wettable sulphur
noculated plants, UP = ninoculated plants

stat. analysis needed

CHAPTER - IV

DISCUSSION

Chickpea (*Cicer arietinum* L.), an important crop of dryland farming is a good source of protein. Amongst different diseases which damage the crop, wilt of chickpea caused by *Fusarium oxysporum* f.sp. *ciceri* is of no less importance. Being a soil borne, it influences the soil microflora and also is influenced by the soil microflora. Amongst the different soil mocroflora, some are advantageous and others disadvantageous to the organims causing the disease. Those disadvantageous to causal organism help the plant to overcome the pathogenic effect and have been exploited for biological control of the disease.. The aim of the present studies has been to determine the soil mycoflora of chickpea infected with *F. oxysporum* f.sp. *ciceri* and to determine the changes in the soil mycoflora as a result of foliar sprays with growth regulators, fertilizers and pesticides and soil amendment with oil cakes, fertilizers and fungicides so as to understand the dynamics of soil mycoflora.

The population of fungi has been high in the rhizosphere of both inoculated and uninoculated plants as compared to

non-rhizosphere. This is understandable as the rhizosphere zone is rich in amino acids, carbohydrades and growth promoting substances in the form of root exudation, which have already been reported to have stimulating effect on fungi. These findings are thus in agreement with earliar studies (Starkey, 1929, 1931 and 1958; Timonin, 1940a,b; Lochhead, 1959; Maliszewska and Moreau, 1959; Reddy, 1959; Ivarson and Katznelson, 1960; Rauatt and Katznelson, 1961; Zagallo and Bollen, 1962; Rangaswamy and Vasantharajan, 1962; Rovira, 1963; Singh, 1971; Rai and Upadhyay, 1980 and Tandon and Tiwari (1982). Moreover, the fungal population has been high in the rhizosphere of plants inoculated with wilt causing organism as compared to uninoculated ones throughout the studies. In the diseased plants there has been greater metabolic activity leading to more root excretions, which might be one of the reasons for more activity of fungi (Agnihothrudu, 1957 and 1959; Timonin, 1966; Wood, 1967; Mathur and Chauhan, 1972; Babushkina., 1973; Rai and Upadhyay, 1980; Kumar and Balasubramanian, 1981; Satyaprasad, 1982; Wadhwani and Mehrotra, 1982; Vesely, 1985 and Suteri, 1986). This is further supported by the fact that the concentrations of total free amino acids, phenols, O-dihydroxy phenols and sugars has been higher in the roots of inoculated than to uninoculated plants. These compounds might have leached out in the soil thus providing more stimulation of fungi (Wood, 1967; Mathur and Chauhan, 1972; Srivastava and Mishra, 1972;

Khan et al., 1973; Babushkina, 1973; Rai and Upadhyay, 1980; Ashour et al., 1980; Wadhwani and Mehrotra, 1982; Kishan et al., 1982; Ansari and Prakash, 1985 and Suteri, 1986). Satyaprasad and Rama Rao (1983) also concluded that amino acids and sugars in the root exudates exert a marked influence on germination of conidia and chlamydospores of F. oxysporum f.sp. ciceri in the root region leading to root infection.

The rhizosphere and rhizoplane mycoflora of different cultivars of chickpea inoculated with F. oxysporum f.sp. ciceri exhibit differences both qualitatively and quantitatively. Cultivar H-208 harboured highest number of fungi in the rhizosphere, while H-208 and JG-62 in the rhizoplane. The fungus population has also been high in the cultivar H-208 and least in JG-74 in both inoculated and uninoculated plants. Amongst different fungi isolated the frequency of Aspergillus niger has been high in the rhizosphere and rhizoplane of uninoculated plants of all the cultivars while that of F. oxysporum f.sp. ciceri in the rhizosphere and rhizoplane of those cultivars which happen to be susceptible to the disease. However in BG-315, BG-212 and JG-74, which otherwise less prone to disease, Aspergillus fumigatus and A. flavus dominated. In all the cultivars, the frequency of parasitic forms has been high in those inoculated with F. oxysporum f.sp. ciceri and those of saprophytic fungi

in uninoculated plants (Table - 4,5). This difference in the fungal flora and population in the rhizosphere and rhizoplane of various cultivars could be due to variations in the root exudates. These results thus are in conformity with those of Subbarao and Bailey (1961), Parkinson (1967), Gujrati (1969), Jalali and Suryanarayana (1972), Sullia (1973), Srivastave (1974), Rataj Guranowsky (1981) and Tandon and Tiwari (1982). The frequency of antagonistic fungi such as Trichoderma viridae and Aspergillus terreus has been high in rhizosphere of those cultivars where the frequency of F. oxysporum f.sp. ciceri has been low and which are less prone to disease. This possibly explains in part the poor development of F. oxysporum f.sp. ciceri in such cultivars.

It is interesting to note that the cultivars which harbour more fungi and have higher frequency of F. oxysporum f.sp. ciceri both in the rhizosphere and rhizoplane have usually low concentrations of phenols, O-dihydroxy phenols but higher concentration of sugars (Table -2). The reverse was true with cultivars which harbour lower number of fungi together with lower frequency of F. oxysporum f.sp. ciceri. The role of phenols and O-dihydroxy phenols in the resistance of plants against disease has already been emphasized (Sharma et al., 1982 and Mikzak et al., 1985a). Alanine, Aspartic acid, Glutamic acid and Glycine have been detected in the root

extracts of all the cultivars while Asparagine, Lysine and Histidine in JG-62, H-208, JG-309 and BG-212; Serine in H-208, BG-309, JG-313, BG-212 and JG-74; Phenylalanine in JG-62, H-208, BG-309, BG-212 and JG-74; Tryptophane and Valine in JG-62, H-208 and JG-309; Tyrosine in JG-315, BG-212, and JG-74; Cysteine in BG-212 and JG-74 and Lucine in JG-315. The number of amino acids however, varies from 8-12 in different cultivars, the highest being with H-208 and BG-309 followed by JG-62, JG-315, BG-212 and JG-74. There has been, however, no difference in the number of amino acids in inoculated and uninoculated plants of different cultivars. The number of amino acids have been relatively high in the cultivars susceptible to wilt causing organism i.e. JG-62, H-208 and BG-309 as compared to BG-212 and JG-74 which are less damaged. The amino acid and sugar composition of the root exudates is likely to affect the C/N ratios, which in turn affect the growth of fungi in the root region (Cook and Schroth, 1965). It is likely that more amino acids together with high concentration of sugar might be favouring the growth of F. oxysporum f.sp. ciceri in the soil and inside the roots. Subbarao and Bailey (1961) also reported that susceptible variety of tomato to Verticillium wilt contained more amino acids in the root exudates than the resistant variety. Satyaprasad and Rama Rao (1983) also found more amino acids in the root exudates of susceptible in comparison to resistant variety of chickpea. It has been

suggested that higher number of amino acids possibly contribute more soluble nitrogenous material to the rooting medium and thus help the pathogen to effectively colonize. In the present studies cysteine has been detected in cv. BG-212 and JG-74 which are less damaged by the wilt causing organisms. This might be a contribution towards the resistance of plants against the disease. Similar correlation of resistance to amino acid content have been made in cotton to Xanthomonas campestris pv. malvacearum (Vohra and Chand, 1971) and greengram to Xanthomonas campestris pv. phaseoli (Marimithu, 1983). Lysine, Valine, Asparagine and Histidine which were detected only in the roots of the susceptible variety are already known for their stimulatory effect on the growth of fungi (Leonian and Lilly, 1940; Lilly and Barnett, 1951; Cochrane, 1958 and Schroth and Snyder, 1961).

The increase a concentration of amino acids in infected plants could in part be due to degradation of protein into amino acids due to production of toxins by the pathogen, and/or activation of enzymes involved in the amino acid and amide synthesis, and/or inhibition of enzymes by the pathogen which are involved in the protein synthesis (Goodman et al., 1967; Tandon, 1970 and Jalali and Suryanarayana, 1972).

Remove Not a Table II

In the studies dealing with the age of plants on rhizosphere and rhizoplane mycoflora. The population of fungi increased with the increase in age of plant upto

75 days followed by decline; this indicating highest rhizosphere effect during flowering and fruiting stages (Table - 6). During senescence, the rhizosphere effect however declines. These findings are in conformity with Starkey (1929), Krossilnikove et al. (1936), Parkinson (1957), Timonin (1940), Agnihothrudu (1957b), Riviera (1959), Rouatt (1959), Katznelson (1961), Rao (1962), Parkinson et al., (1963), Khasanova (1967), Ranga Rao (1971), Sudha Mall(1977), Kannaiyan and Prasad (1981), Behera and Patnaik (1982) and Gamel-El-Din et al. (1983). In the present studies senenscence brings about decline in rhizosphere effect which is at variance with Rao (1962), Gujrati (1969) and Khan and Prakash (1982) who reported an increased rhizosphere effect during senescence. During vegetative growth of plants, the metabolic activity is high enough to release amino acids, carbohydrates and growth promoting substances in high concentration which might probably result in more rhizosphere mycoflora. However, during senescence, the old tissues decay when less nutrients might be readily available. By and large, the frequency of most of the parasitic forms increase in the rhizosphere and rhizoplane of inoculated plants with the increase in age of the plant. However, in uninoculated plants, the frequency of most of the saprophytic forms increased. The frequency of parasitic forms was higher in the rhizosphere and rhizoplane of inoculated plants. On

the other hand, the frequency of saprophytic fungi was higher in uninoculated plants. This indicates that in the rhizosphere of inoculated plants, parasitic fungi, partiuclarly F. oxysporum f.sp. ciceri dominate. Reverse was, however, true with uninoculated plants. Similar results were obtained by Vesely (1985) with sugarbeet in relation to dampin-off fungus.

As a result of inoculation, differences have been observed in the rhizosphere and rhizoplane mycoflora of diseased and healthy plants at different stages of plant growth. Similar results were reported by Parlik, 1950; Timonin, 1966; Hong, 1969; Rai and Upadhyay, 1980 and Vesely, 1985. It has been reported that root exudates in the form of amino acids and carbohydrates have a distinct selective action on the rhizosphere microorganisms resulting in the stimulation of certain groups and suppression of the others (Lochhead, 1940; Gujrati, 1969 and Tandon and Tiwari, 1982). In the beginning, infection by the pathogen induces changes in chemical composition of the host which might be advantageous to some fungi and disadvantageous to others. Higher concentration of amino acids, phenols, O-dihydroxy phenols and sugars have been found in the inoculated plant roots in comparison to uninoculated counterparts. These results are in conformity with those of Wood (1967), Jalali and Suryanarayana (1972), Singh

et al. (1978) and Suteri (1986). Karimbaeva and Sizova (1977) reported a direct relationship of concentration of root exudates on growth of fungi.

Certain forms of fungi are recorded throughout the growth period of plants; however, others are restricted to a particular stage of growth. By and large, Aspergillus sp. constitute dominant mycoflora throughout the growth period in uninoculated plants but in the inoculated plants, F. oxysporum f.sp. ciceri and other parasitic fungi constitute the dominant mycoflora throughout the growth of plants. This is in conformity with Mathur and Chauhan (1972) and Satyaprasad and Rama Rao (1983). The variation in the rhizosphere and rhizoplane mycoflora due to age of plant may probably be due to qualitative and quantitative changes in the root exudates at various growth stages as reported by Scroth and Hildbrend (1964), Katznelson (1965), Rovira (1965) and Vesely (1985). In the present studies there has been an increase in the concentration of total free amino acids, phenols, O-dihydroxy phenols and sugars in the roots (of inoculated and uninoculated) with the increase in the age of plants upto 90 days followed by a decline.

A slight decline in the population of fungi after fruiting stage may be attributed due to moisture stress as in this crop only one irrigation is done during plant growth or in part may be due to seasonal variation in temperature

and moisture. Gangawane and Deshpande (1977) also explained that qualitative and quantitative differences in the fungal flora could be due to a response to seasonal variations. Gujrati (1968) showed that a change in the moisture content had a pronounced effect on the fungal flora of chickpea and lentil. The activity of F. orthoceras var. ciceri has been correlated with moisture content of soil (Chauhan, 1963). Bissett and Parkinson (1979) also pointed out that temperature, moisture, available K, and soil pH are the most important abiotic variables influencing the distribution and composition of soil mycoflora.

Sprays with growth promoting substances have been found to increase the populations of fungi in the rhizospheres of both the cultivars JG-62 and JG-74 except maleic hydrazide where there has been some reduction (Table - 10,11). Similar observations regarding changes in rhizosphere populations of fungi due to foliar sprays with growth promoting substances have been reported by Vrany et al. (1962), Ray and Dwivedi (1967), Sullia (1968), Misra and Gujrati (1969), Singh (1970), Gupta (1971), Dwivedi and Singh (1971) and Singh (1981). It appears that sprays with chemicals might influence the metabolic activity in plants (Singh and Murty, 1987) which in turn influence the root exudation. The root exudates influencing the rhizosphere populations has already been documented (Vrany et al., 1962, Agnihotri, 1964 and Singh, 1981)

The spraying of plants with indole acetic acid, indole butyric acid, thio-indole butyric acid and gibberellic acid results in increase in the frequency of fungi; however, with maleic hydrazide there has been a decrease of majority of fungi (Tables - 12,14,16 and 18). There has been more increase in the frequency of saprophytic fungi more in the rhizosphere of uninoculated plants. With maleic hydrazide spray, there has been some increase in the frequency of A. fumigatus in inoculated plants, A. niger in uninoculated plants of both the cultivars; Trichoderma lignorum and Fusarium oxysporum in uninoculated plants of JG-74 and JG-62 respectively. The differences could be due to changes in the root exudates of the plants. In plants sprayed with growth promoting substances, the growth promoters are absorbed by the leaves and undergo metabolic changes in the tissue leading to activation of various enzymes such as peroxidases etc. (Sembdner et al., 1980). The metabolic products are leached out of the roots. It is likely that the metabolic products of maleic hydrazide leached out are toxic for most of the fungi in the rhizosphere (Dwivedi and Singh, 1971). The increase of certain asprophytic forms such as A. niger, T. lignorum in the rhizosphere of plants treated with maleic hydrazide is of some importance which could be used for disease management (Mathur and Chauhan, 1972; Gokulapalan and Nair, 1984; Venkatasubbaiah and Safeulla, 1984 and

Zozzerini and Tosi, 1985).

Results on the effect of foliar sprays with fertilizers indicate that, by and large, sprays with urea exhibit stimulatory effect on the rhizosphere population of fungi both in inoculated and uninoculated plants while muriate of potash have an inhibitory effect (Tables - 10,11). These results are in agreement with Agnihotri (1964), Ramachandra Reddy (1959 and 1968), Dwivedi and Singh (1971) and Rao and Raja (1978) who reported an increase in rhizosphere population of fungi with sprays of urea but are slightly in disagreement with Vrany (1963 and 1972) and Annapurna and Rao (1983) who point out decrease in the number of fungi as a result of spray.

Significant effect of spray with urea on frequency of rhizosphere fungi has been observed only after 2nd and 3rd sprays in both the cultivars (Tables - 12,14,16 and 18). The urea when sprayed is probably absorbed by the leaves and is transformed (Throne, 1954 and Boynton, 1954) into more amino acids such as glutamine, glutamic acid and α-aminobutyric acid, which exude out from the roots (Agnihotri, 1964 and Steward and Durzan, 1965). These might be providing a stimulatory effect on fungi (Leonian and Lilly, 1940, Lilly and Barnett, 1951, Cochrane, 1958 and Schroth and Snyder, 1961).

With muriate of potash, although overall decrease has been observed in mycoflora but while comparing the two groups of fungi i.e., parasitic and saprophytic, the saprophytic fungi indicate an increase while that of parasitic fungi a decrease. High amounts of potassium in soil are believed to reduce infection with several soil borne fungi (Lewis, 1979 and Huber, 1979). The increase in potassium levels might increase the vigour of plants thus resulting in root exudates unfavourable to parasitic fungi of rhizosphere. It is interesting to note that in the rhizosphere of inoculated plants of JG-74, a cultivar relatively less susceptible to F. oxysporum f.sp. ciceri, there has been a significant increase in frequency T. viridae with sprays of potash, the fungus knwon for antibiosis (Gokulapalan and Nair, 1984) ~~might in part be responsible for reduction in frequency of parasitic forms in these studies.~~ This can be exploited for disease control (Martinez Vicra and Garcia Gomez, 1984).

Inhibition in the population of rhizosphere fungi has also been observed with sprays of bavistin, vitavax, brassicol, benlate, captan and wettable sulphur both in inoculated and uninoculated plants in both the cultivars JG-62 and JG-74 (Tables 10,11). This kind of inhibition in the rhizosphere mycoflora with fungicidal sprays has also been observed by Helleck and Cochrane (1950), Sullia (1969), Srivastava and Mishra (1971), Ranga Rao et al. (1972), Balasubramanian and

Rangaswami (1973), Wainwright and Sowden (1977), Srivastava and Dayal (1981), Gunaseka and Rao (1982) and Abdul Kader et al. (1983). The frequency of majority of the parasitic fungi including F. oxysporum f.sp. ciceri decrease due to foliar sprays with fungicides in the rhizosphere and rhizoplane while that of saprophytic fungi such as Aspergillus clavatus and T. viridae increase (Tables - 13,15,17 and 19). The more increase in the frequency of A. clavatus and T. viridae in the rhizosphere and rhizoplane of JG-74 (known for antibiosis (Wakssman, 1952 and Gukulapalam and Nair, 1984)) might be one of the reason for poor infection in the cultivar JG-74. Diathan Z-78 (200 ppm) has been found to influence the exudation of amino acids from the roots of Sorghum vulgare and Crotalaria jancea L., adversely resulting in the reduction in rhizosphere population (Balasubramanian and Rangaswami, 1973). It is likely that similar mechanism might be operating here also. Antibiotic streptomycin, on the other hand, has been found to stimulate the rhizosphere fungal flora in the present studies. These results are in agreement with those of Gupta (1974), Chandra et al. (1982) and Bagyaraj and Rangaswami (1982). It is likely that antibiotic sprays reduce the bacterial counts in the rhizosphere, thus reducing the antibiosis or antagonistic effects on fungi which probably results in increase in soil rhizosphere fungi (Chandra et al., 1982). The possibility of the changes in the physiology and root exudation of the plants favouring growth of fungi in the

rhizosphere however, cannot be ruled out (Gupta, 1974 and Chandra et al., 1982).

Incorporation of different fertilizers in the form of urea, superphosphate, muriate of potash and oil cakes such as castor cake, neem cake, mustard cake results in an increase in the rhizosphere population of fungi in uninoculated plants of both the cultivars JG-62 and JG-74 while in inoculated ones, there has been a decrease in the rhizosphere activity except with urea and superphosphate. However, incorporation of mahua cake and different fungicides brings about a decrease in rhizosphere population of fungi in uninoculated and inoculated plants, of both the cultivars (Table - 20). These results are in agreement with those of Mosolove et al. (1959), Mishra (1972), Jarden et al. (1972), Jalaluddin(1975), Donech et al. (1983) and Tostensson and Wessen (1984). It is interesting to note that in the rhizosphere and rhizoplane of cultivar JG-62, F. oxysporum f.sp. ciceri was not detected in soil amended with mahua cake, neem cake, bavistin, while in JG-74 it was not detected after treatment with castor cake, mahua cake, neem cake, bavistin and benlate. The rhizosphere of inoculated plants is predominated by parasitic/pathogenic fungi (Tables-21,22,23 and 24) which are adversely affected with muriate of potash, oil cakes and fungicides in the rhizosphere mycoflora (Jarden et al., 1972; Sinha, 1975; Haider et al., 1978; Singh et al., 1980; Upadhyay and Rai, 1981; Huang and Sun,

1982; Sulochna et al., 1983; Singh et al., 1985 and Sinha and Prasad, 1986).

It is likely that soil treatment with inorganic fertilizers may induce fresh root formation resulting in increase root exudation in the plants which provide more substrate for rhizosphere and rhizoplane microorganisms. This might be one of the reasons for higher population and frequency of fungi. In inoculated plants, urea and superphosphate favour the activity of F. oxysporum f.sp. ciceri and other pathogenic forms (Tables-21,22,23 and 24). Similar results were obtained by Papendick and Cook (1974), Gamel-El-Din et al. (1983) and Rai and Upadhyay (1983).

Oil cakes, the product left after extraction of oils, contain sufficiently higher amount of liginin, cellulose and other carbohydrates, certain nitrogenous materials etc. which are suitable for all types of colonizers, thus resulting in the increase of fungal population particularly saprobes. Soil amendment with different oil cakes probably acts on pathogenic forms in many ways. Its decomposition products may be deleterious to the pathogenic forms, or it improves soil structure resulting in better growth of plants with modified root exudation unfavourable for pathogenic forms, or the degradation products which when exuded out reduce the activity of parasitic forms (Huber and Walson, 1970; Kirmani, 1977; Upadhyay and Rai, 1981; Son et al.,1985

Nishat Khalis and Manoharachary, 1985 and Sinha and Prasad 1986. Lastly there may be phenomenal increase in antagonistic forms of fungi such as T. viridae (Evans, 1955; and Saksena, 1960). In the present studies also there has been an increase in the frequency of T. viridae in oil cake amended soil which might also be contributing towards poor development of wilt. There has also been an increase in the frequency of Aspergilli and Penicilli in the rhizosphere of oil cake amended soil. Inhibitory effect of culture filtrate of A. niger is already known against F. oxysporum f.sp. ciceri (Mathur and Chauhan, 1972), Sinha and Prasad (1986) reported that castor cake and soybean leaves were more effective in reducing chickpea wilt disease. Similar results on the reduction of parasitic forms due to soil amendment with Azadiracta indica have been reported by Singh et al. (1980).

Inhibitory effect on soil microorganisms as a result of soil treatment with pesticides have been reported by Bollen et al. (1954), Bollen (1961), Lebed (1964), Tu (1972 and 1973), Singh and Prasad (1973), Midhu and Nandwana (1974), Bertoldi et al. (1977 and 1978), Jain and Sehgal (1980), Sinha et al. (1980) and Bollen et al. (1983). The decrease in the activity of parasitic fungi with the amendment of fungicides might be due to decrease in competitive saprophytic colonization of parasitic forms or increase in

saprophytic forms (Vaartaja and Agnihotri, 1970 and Rai and Upadhyay, 1983). Moreover, changes in soil microbial enzyme activity cannot be ruled out (Munchi et al., 1988).

It, therefore, appears that the rhizosphere and rhizoplane mycoflora of chickpea is influenced by several factors. The rhizosphere and rhizoplane mycoflora of chickpea plants inoculated with Fusarium oxysporum f.sp. ciceri is different from those uninoculated ones, whereas in the former, the pathogenic forms predominate while in the later saprophytic forms. Highest activity of rhizosphere/rhizoplane mycoflora is observed at flowering and fruiting stage and not at senescence. Different cultivars differ in the rhizosphere and rhizoplane mycoflora both qualitatively and quantitatively. Sprays with various fertilizers, growth promoting substances, pesticides and soil treatment with different fertilizers, oil cakes, fungicides influenced the rhizosphere and rhizoplane mycoflora in many ways. The frequency of Trichoderma viridae has been considerably increased due to application of oil cakes while parasitic forms such as Fusarium oxysporum f.sp. ciceri is decreased, These changes in the mycoflora appears to be influenced by the root exudates which are affected by various treatments. The present studies go a long way in exploring and envisaging different possibilities where the rhizosphere mycoflora could be modified by foliar applications and soil amendment for control of

This statement is not valid since only minor differences were shown (not enough to affect control over a season) and these were not shown to be statistically significant differences verified by repeating the experiment.

root diseases. Brian (1957) also mentioned that succesful control of root diseases probably lies in the development of satisfactory methods for influencing the rhizosphere microflora.

SUMMARY

Rhizospheres of uninoculated chickpea plants and those inoculated with Fusarium oxysporum f.sp. ciceri harboured more fungal population than non-rhizosphere soil. Higher fungal populations were encountered in the rhizospheres of inoculated plants than in uninoculated ones. The concentration of total free amino acids, phenols, O-dihydroxy phenols and sugars was also high in the root extract of inoculated chickpea plants. By and large, the number of fungi was more in inoculated plants than in uninoculated ones. In the rhizosphere and rhizoplane of inoculated plants, parasitic fungi, particularly F. oxysporum f.sp. ciceri, dominated while saprophytic forms dominated in uninoculated plants.

2. There have been both qualitative and quantitative differences in the rhizosphere and rhizoplane mycoflora of different cultivars irrespective of the fact of their being inoculated with F. oxysporum f.sp. ciceri. Cultivar H-208 harboured the highest number of fungi in the rhizosphere while H-208 and JG-62 had the highest numbers in the rhizoplane. The fungus population was also high in the cultivar H-208 and least in JG-74 in both inoculated and uninoculated plants. There have been differences with regard to concentration of total free amino

acids, phenols, O-dihydroxy phenols and sugars in the roots of different cultivars with higher concentrations in inoculated plants than in uninoculated ones. The frequency of F. oxysporum f.sp. ciceri was also high in the rhizosphere and rhizoplane of cultivar JG-62, which supported more abundant rhizosphere and rhizoplane mycoflora, and least in JG-74, being less supportive to the rhozosphere and rhizoplane mycoflora.

3. The population of fungi in the rhizosphere increased with increase in age of plants upto the flowering and fruiting stages, followed by decline. The frequency of F. oxysporum f.sp. ciceri also increased with increase in age of the plants and attained the highest value when plants were 75 days old. The concentration of total free amino acids, phenols, O-dihydroxy phenols and sugars was highest at the age of 75 to 90 days old plants. By and large, Aspergillus spp. constituted the dominant mycoflora throughout the growth period in uninoculated plants. On the other hand F. oxysporum f.sp. ciceri and other parasitic fungi dominated in inoculated plants.

4. Indole acetic acid, indole butyric acid, thio-indole butyric acid, gibberellic acid, urea and streptomycin when applied as foliar sprays, showed inhibitory effect on the rhozosphere and rhizoplane mycoflora of inoculated and uninoculated plants of both the cultivars JG-62 and JG-74;

however, sprays with maleic hydrazide, muriate of potash, bavistin, vitavax, brassicol, benlate, captan and wettable sulphur exhibited inhibitory effect. The frequency of F. oxysporum f.sp. ciceri increased in the rhizosphere and rhizoplane when sprayed with indole acetic acid, indole butyric acid, thio-indole butyric acid, gibberellic acid, urea and streptomycin and decreased with maleic hydrazide, muriate of potash and different fungicides. F. oxysporum f.sp. ciceri was not isolated from rhizosphere and rhizoplane of both the cultivars when plants were sprayed with bavistin in the rhizosphere and rhizoplane of JG-74 and rhizosphere of JG-62 when plants when sprayed with benlate.

5. Soil amendment with different fertilizers in the form of urea, superphosphate, muriate of potash and oil cakes such as castor cake, neem cake, and mustard cake resulted in an increase in the rhizosphere population of fungi in uninoculated plants of both JG-62 and JG-74 but in inoculated ones there was a decrease in the rhizosphere population in all the treatments except with urea and superphosphate. The soil amendment with mahua cake and with different fungicides brought about a decrease in rhizosphere population of fungi both in inoculated and uninoculated plants of the two cultivars. There was an increase in the frequency of F. oxysporum f.sp. ciceri in soil amendments with urea and superphosphate but decreases in the remaining treatments. F. oxysporum

f.sp. *ciceri* was either not detected or its frequency was low in the rhizosphere and rhizoplane of the plants.

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